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USE OF Ni^{63} OVERVOLTAGE GAP SWITCHES IN THE FLIGHT TERMINATION SYSTEMS ON BOOSTERS LAUNCHED FROM U.S. ARMY KWAJALEIN ATOLL (USAKA)

MAY 1990

U.S. ARMY SDC

ENVIRONMENTAL ASSESSMENT

FINDING OF NO SIGNIFICANT IMPACT

UNITED STATES ARMY STRATEGIC DEFENSE COMMAND

AGENCY: United States Army Strategic Defense Command.

ACTION: Use of Ni^{63} Overvoltage Gap Switches in the Flight Termination Systems on Boosters Launched from U.S. Army Kwajalein Atoll (USAKA).

BACKGROUND: Pursuant to Council on Environmental Quality regulations for implementing the procedural provisions of the National Environmental Policy Act (40 CFR parts 1500-1508), the Compact of Free Association (42 USC 1681), the Department of Defense (DOD) Directive on Environmental Effects in the United States of DOD Actions, and Army Regulation 200-2, the United States Army Strategic Defense Command (USASDC) has conducted an assessment of the potential environmental consequences of the use of Ni^{63} overvoltage gap switches in the flight termination systems on boosters launched from U.S. Army Kwajalein Atoll (USAKA). A no-action alternative was also considered.

SUMMARY: As part of the Strategic Defense Initiative Program, the Ground Based Interceptor (GBI) is being developed to demonstrate the capability to intercept strategic ballistic missiles outside the atmosphere. To satisfy range safety regulations and ensure public safety for GBI test launches, a reliable and safe Flight Termination System (FTS) is required.

The original GBI FTS contained no radioactive material. However, FTS failures occurred during qualification testing of the firing unit hardware, and a timely, innovative design could not be developed that would support program schedules. Portions of a proven firing unit used in the Navy's Trident program will be adapted to the GBI FTS. A component of this unit is an overvoltage gap switch which contains the radioisotope Ni^{63}.

Since use of this device was not planned at the time the original environmental analyses were conducted for this project, this Environmental Assessment (EA) is required to assess the potential environmental consequences of incorporating Ni^{63} switches in the FTS of GBI boosters to be launched from Meck Island, USAKA, Republic of the Marshall Islands. The analysis contained in this EA are tiered from the Environmental Impact Statement on Proposed Actions at U.S. Army Kwajalein Atoll (USAKA EIS) produced by the USASDC in 1989 and from the Exoatmospheric Reentry Vehicle Interception System (ERIS) EA produced by the Strategic Defense Initiative Organization (SDIO) in 1987. The ERIS, a subsystem of

FINDING OF NO SIGNIFICANT IMPACT

UNITED STATES ARMY STRATEGIC DEFENSE COMMAND (CONTINUED)

the Phase I Strategic Defense System (SDS) and an Army project, has been renamed the "Ground Based Interceptor" project. Material pertaining to the general aspects of the GBI project is in the ERIS EA (SDIO, 1987). Pertinent information relating to launch operations from USAKA were addressed in the USAKA EIS (USASDC, 1989).

Use of the Ni^{63} overvoltage gap switches would involve activities at two locations. These locations and activities are:

LOCATION	ACTIVITY
Lockheed Missiles and Space Company, Sunnyvale, California	Assembly and Test of the FTS
Meck Island, USAKA, Republic of Marshall Islands	Installation, Flight Preparation, and Flight

To assess possible impacts, each activity was evaluated in the context of the environmental considerations for air quality, biological resources, cultural resources, hazardous waste, infrastructure, land use, noise, public health and safety, socioeconomics, and water quality.

FINDINGS: No significant impacts would result from the use of Ni^{63} overvoltage gap switches during normal flight of the GBI. In addition, dispersion calculations were made for other non-routine scenarios: 1) flight termination in the launch pad area resulting in pulverization of the Ni^{63} switches, 2) flight termination at about 8 km (5 mi) altitude with pulverization of the switches and aerial dispersion, and 3) flight termination resulting in the switches fragmenting and falling into the ocean in small pieces. These calculations indicate that no significant impacts to the environment will occur even in the event of the non-routine scenarios evaluated.

Following careful consideration and evaluation of the potential impacts of substituting a firing unit with overvoltage gap switches containing a radioisotope of Nickel (Ni^{63}), I have determined that no significant environmental impacts would occur as a result of this action.

FINDING OF NO SIGNIFICANT IMPACT

UNITED STATES ARMY STRATEGIC DEFENSE COMMAND (CONTINUED)

DEADLINE FOR RECEIPT OF PUBLIC COMMENTS: July 29, 1990

POINT OF CONTACT: A copy of the Environmental Assessment for: Use of the Ni^{63} Overvoltage Gap Switches In The Flight Termination Systems On Boosters Launched From U.S. Army Kwajalein Atoll (USAKA), May 1990, is available from:

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ABSTRACT *(Continue on reverse if necessary and identify by block number)*

This Environmental Assessment documents the results of an analysis of the potential for and the magnitude of impacts resulting from using Overvoltage Gap Switches containing Ni63 radioisotopes in the Flight Termination System of the Ground-Based Interceptor Boosters launched from the U.S. Army Kwajalein Atoll

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TITLE OF PROPOSED ACTION:	Use of Ni^{63} Overvoltage Gap Switches in the Flight Termination Systems on Boosters Launched from U.S. Army Kwajalein Atoll (USAKA)
AFFECTED JURISDICTIONS:	U.S. Army Kwajalein Atoll, Republic of the Marshall Islands and the Ground Based Interceptor (GBI) prime contractor facility, Lockheed Missiles and Space Company in Sunnyvale, CA.
CONCURRENCE FOR U.S. ARMY KWAJALEIN ATOLL ACTIVITIES:	PHILIP R. HARRIS Colonel, EN Commander U.S. Army Kwajalein Atoll
PROPONENT:	JAMES C. KATECHIS GBI Project Manager

USE OF NI^{63} OVERVOLTAGE GAP SWITCHES

IN THE FLIGHT TERMINATION SYSTEMS

ON BOOSTERS LAUNCHED FROM

U.S. ARMY KWAJALEIN ATOLL (USAKA)

ENVIRONMENTAL ASSESSMENT

MAY 1990

U.S. ARMY STRATEGIC DEFENSE COMMAND
CHIEF, ENVIRONMENTAL OFFICE
(CSSD-EN)
HUNTSVILLE, AL 35807-3801

EXECUTIVE SUMMARY

As part of the Strategic Defense Initiative (SDI) Program, the Ground Based Interceptor (GBI) is being developed to demonstrate the capability to intercept strategic ballistic missiles outside the atmosphere. To satisfy range safety regulations and ensure public safety for GBI test launches, a reliable and safe Flight Termination System (FTS) is required.

The original GBI FTS contained no radioactive material. However, FTS failures occurred during qualification testing of the firing unit hardware, and a timely, innovative design could not be developed that would support program schedules. Portions of a proven firing unit used in the Navy's Trident program will be adapted to the GBI FTS. A component of this unit is an overvoltage gap switch, which contains the radioisotope Ni^{63}.

U.S. Army Regulation 200-2 requires an environmental analysis when a radioactive substance is to be authorized for use. This Environmental Assessment (EA) focuses on the potential environmental consequences of incorporating Ni^{63} switches in the FTS of GBI boosters to be launched from Meck Island, U.S. Army Kwajalein Atoll (USAKA). The analyses contained in this EA are tiered from the Environmental Impact Statement (EIS) on proposed actions at the U.S. Army Kwajalein Atoll produced by the U. S. Army Strategic Defense Command (USASDC) and the Exoatmosphere Reentry Vehicle Interception System (ERIS) EA produced by the Strategic Defense Initiative Organization (SDIO). ERIS, a Phase I subsystem of the Strategic Defense System (SDS) and an Army project, has been renamed the "Ground Based Interceptor" project. Material pertaining to the general aspects of the GBI project is in the ERIS EA (SDIO, 1987a). Pertinent information relating to launch operations and the existing environment at Kwajalein Atoll can be found in the USAKA EIS (USASDC, 1989a,b).

To assess the significance of any potential impacts, a four-step approach was used. The first step was development of a list of the activities necessary to implement the proposed action. The second step was the description of the affected environment at each proposed program location. The third step was the determination of those activities with potential environmental consequences. If a proposed activity was determined to present a potential for impact, the fourth step was undertaken. This step consisted of evaluating the activity in terms of the potential for significant impacts, considering the intensity, extent, and context in which the impact occurs.

Based on the application of this approach, the following environmental consequences for use of the Ni^{63} overvoltage gap switches were determined:

- **Assembly and Test of the Flight Termination System**

  Lockheed Missiles and Space Company, Sunnyvale, California - environmental consequences not significant

- **Installation, Flight Preparation, and Flight**

  Meck Island, U.S. Army Kwajalein Atoll, Republic of the Marshall Islands - environmental consequences not significant

Potential environmental impacts were examined for use of the Ni^{63} during normal flight of the GBI and for dispersion of the Ni^{63} during several non-routine scenarios. Both the predicted annual radiation dosage and the air-water concentrations were determined to be well below the maximum allowable standards in all cases. Due to the nature and complexity of radiation effects on biological organisms, a technical discussion and analysis on the amounts of radiation and their effects are provided in Appendix A of this EA. Therefore, following careful consideration and evaluation of the potential impacts of substituting a firing unit with an overvoltage gap switch containing a radioisotope of Nickel (Ni^{63}), it was determined that no significant environmental impacts would occur as a result of this action.

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1.0 DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

1.1 Scope

The National Environmental Policy Act (NEPA), the Council on Environmental Quality regulations implementing the NEPA (40 CFR 1500-1508), Department of Defense (DOD) Directive 6050.1, and Army Regulation 200-2 which implements these regulations, direct that DOD and Army officials consider the environmental consequences prior to authorizing or approving federal actions. Army Regulation 200-2 [Chapter 2-2, Paragraph a(5)] requires an environmental analysis when a radioactive substance is to be authorized for use. Therefore, the use of a firing unit containing nickel radioisotope (Ni^{63}) overvoltage gap switches [hereafter referred to as switch(es)] in the Flight Termination System (FTS) for the Ground Based Interceptor (GBI) requires preparation of an Environmental Assessment (EA). Because the proposed action would involve U.S. Army Kwajalein Atoll (USAKA), Republic of the Marshall Islands (RMI), the Compact of Free Association (Compact) and related agreements between RMI and the United States apply.

This EA focuses on the potential environmental consequences of incorporating Ni^{63} switches in the FTS on GBI boosters to be launched from Meck Island, USAKA (Figures 1-1 and 1-2). The analyses contained in this EA are tiered from the Environmental Impact Statement (EIS) on proposed actions at USAKA produced by the U.S. Army Strategic Defense Command (USASDC) and the Exoatmospheric Reentry Vehicle Interception System (ERIS) EA produced by the Strategic Defense Initiative Organization (SDIO). ERIS, a subsystem of the Phase I Strategic Defense System (SDS) and an Army project, has been renamed the "Ground Based Interceptor" project. Material pertaining to the general aspects of the GBI project is in the ERIS EA (SDIO, 1987a). Pertinent information relating to launch operations from Kwajalein Atoll can be found in the USAKA EIS (USASDC, 1989a,b).

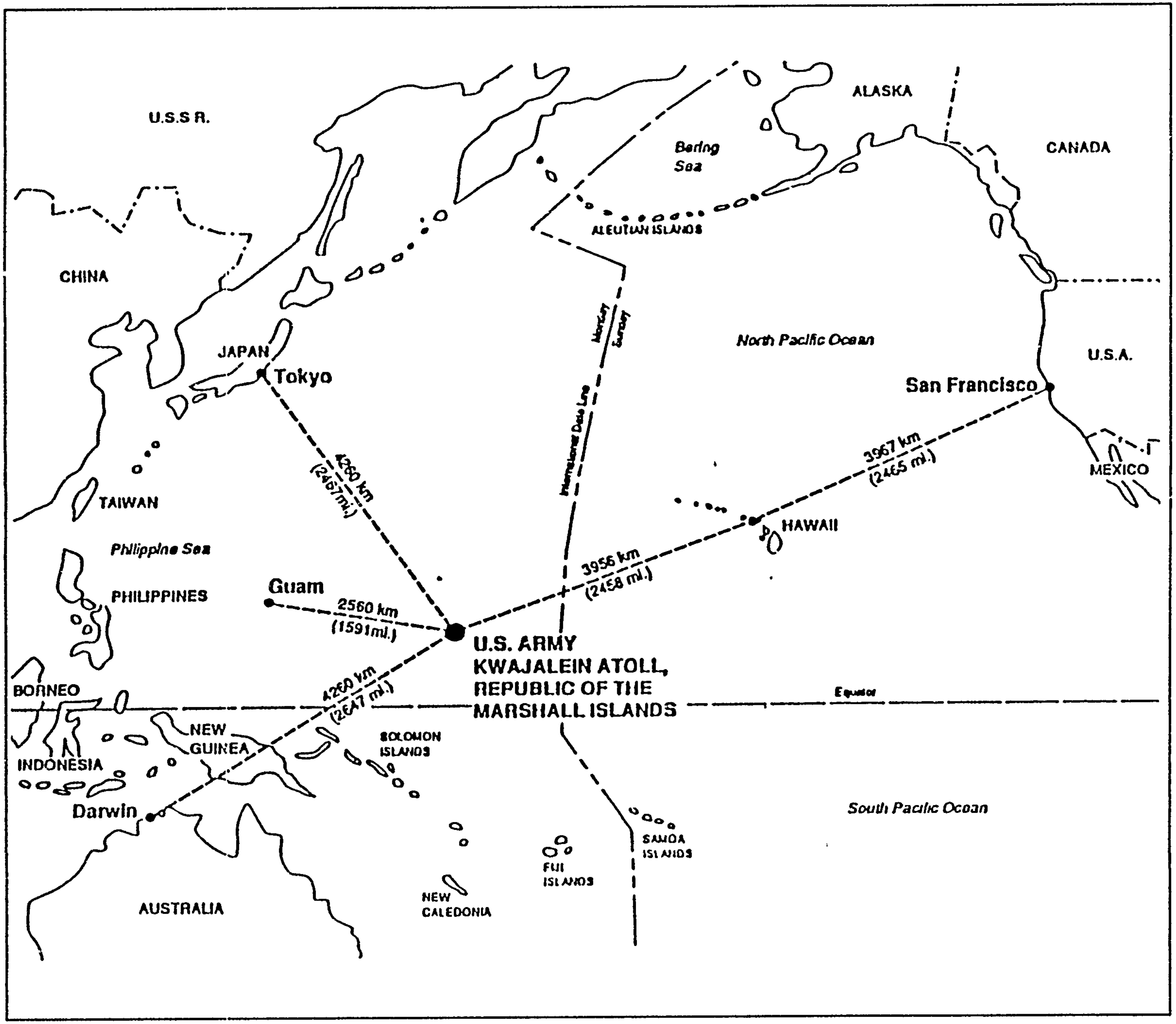
1.2 Background

Consistent with the Strategic Defense Initiative (SDI) program announced by former President Reagan on March 23, 1983, the GBI is being developed to demonstrate the capability to intercept strategic ballistic missile reentry vehicles in the exoatmosphere. To satisfy range safety regulations and ensure public safety for GBI test launches conducted at USAKA, a reliable and safe FTS must be provided.

The original GBI FTS contained no radioactive material. However, FTS failures occurred during qualification testing of the firing unit hardware, and a timely, innovative design could not be developed that would support hardware constraints as well as project schedules. To simplify the qualification process, portions of a proven firing unit used in the Navy's Trident program will be adapted to the GBI FTS. A component of this unit is an overvoltage gap switch, which contains the radioisotope Ni^{63}.

1.3 Purpose and Need for the Action

In compliance with the USAKA Range Safety Manual (USASDC, 1986), the GBI FTS must be reliable and safe. The purpose of the proposed action, the use of a firing unit incorporating a switch containing Ni^{63}, is to provide a reliable and safe FTS. The proposed action is the result



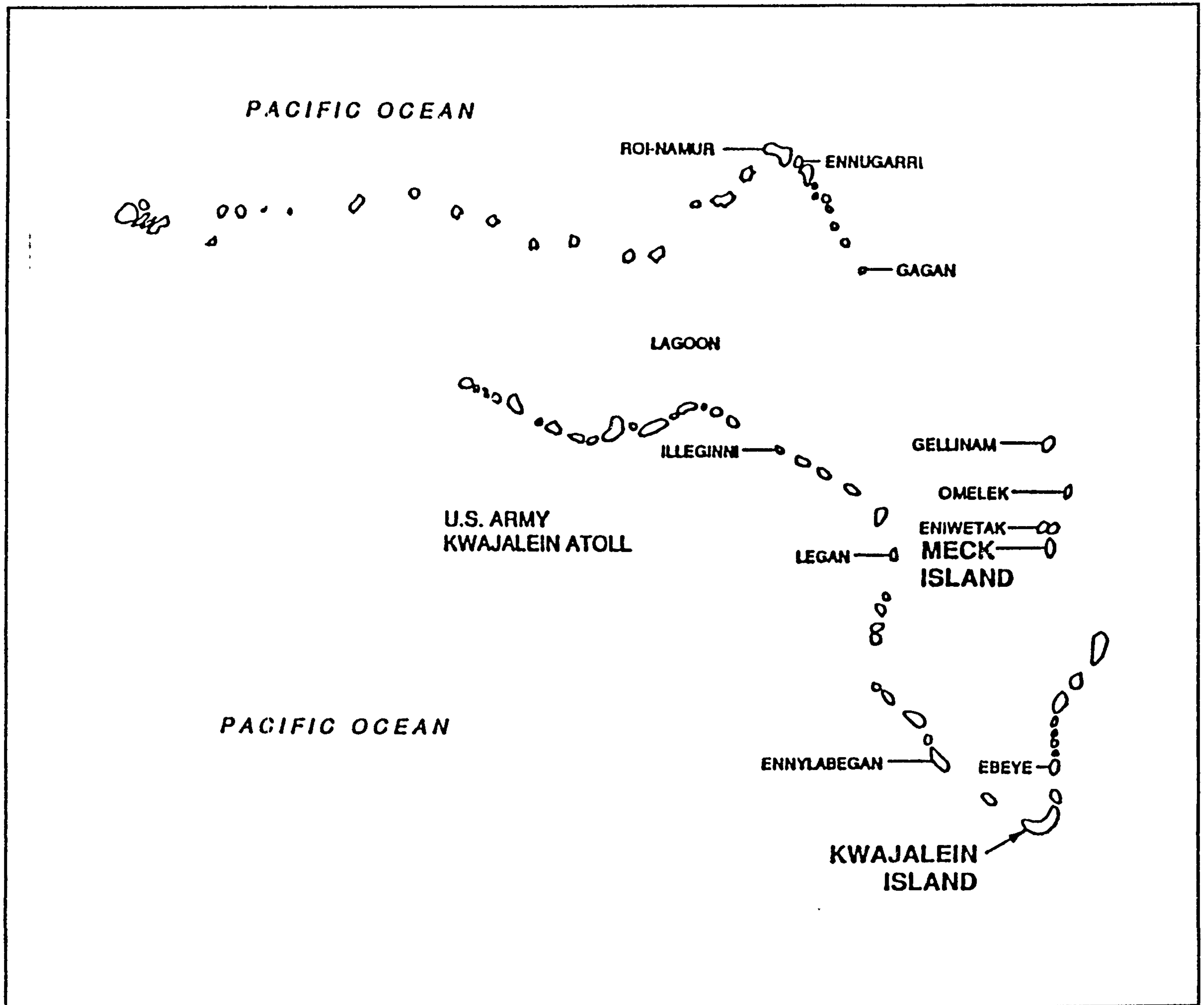
LOCATION OF U.S. ARMY KWAJALEIN ATOLL

NORTH

NOT TO SCALE

Figure 1-1

GBI FLIGHT TEST LAUNCH SITE, MECK ISLAND



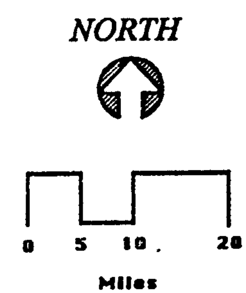


Figure 1-2

of the less than adequate reliability of the earlier Exploding Foil Initiator (EFI) design. The use of an available and proven component from a U.S. Navy firing unit is necessary to ensure public safety with a high degree of reliability and with no delay of schedule.

1.4 Description of the Proposed Action

The FTS provides the means for the Flight Safety Officer to terminate the flight if the flight footprint violates a predetermined protection circle or fails to function according to the missile's flight plan (Figure 1-3). The probability of debris falling outside the flight footprint is less than one in one million (SRS Technologies, 1989). If the flight footprint intersects a protection circle that encloses inhabited islands, the missile then poses a hazard to personnel and property, and its flight will be terminated.

Guided missiles launched from USAKA must be equipped with an FTS in compliance with the USAKA Range Safety Manual (USASDC, 1986). These safety requirements will be in effect for GBI test missions. The GBI test missions are planned to perform within their Flight Safety Corridor (Figure 1-3).

1.4.1 System Description

The operation of the FTS consists of firing the initiators to subsequently activate the destruct charge. This, in turn, splits the booster motor case, resulting in flight termination.

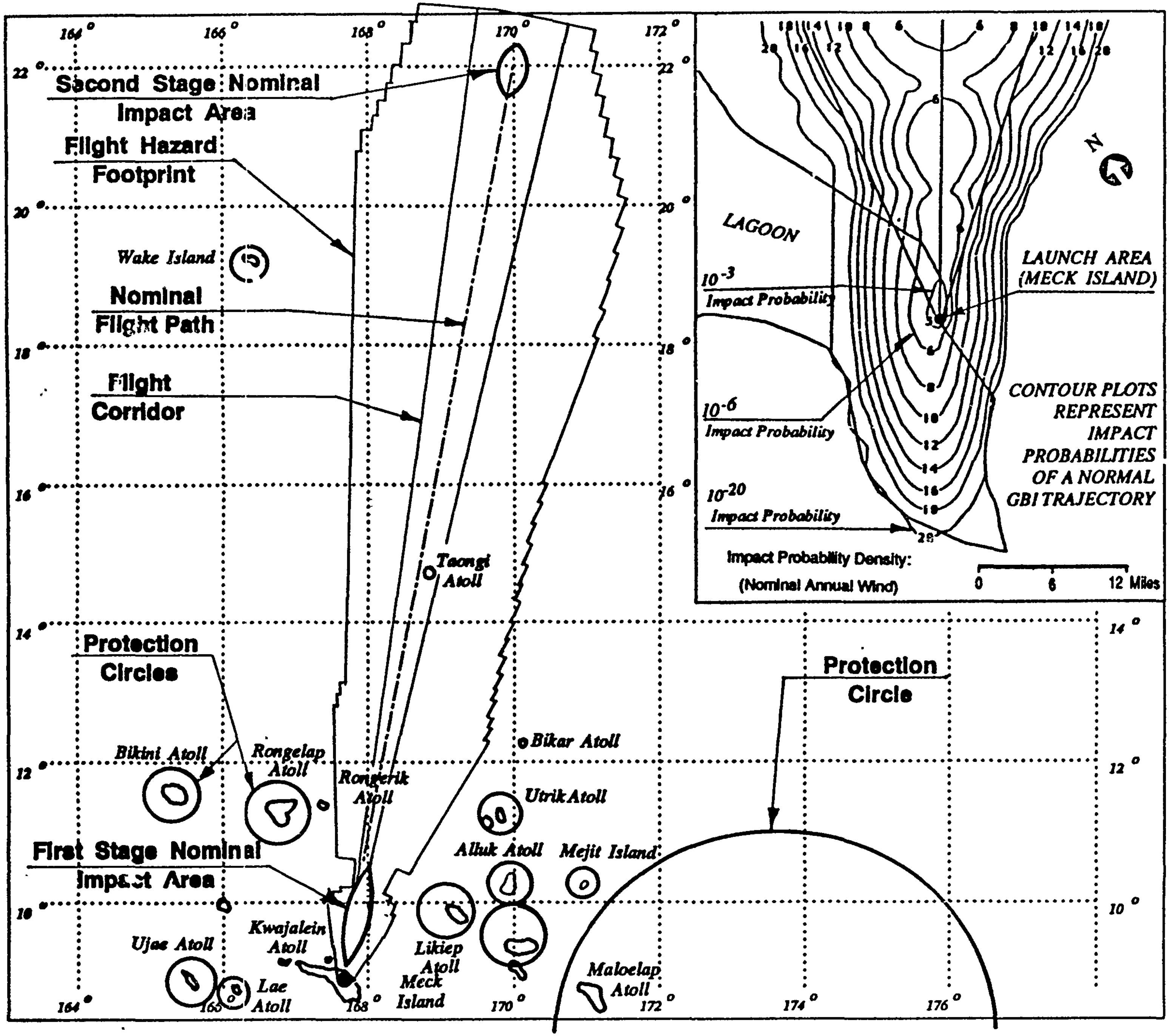
The FTS firing unit consists of a Premature Separation Module, a High Voltage Assembly (HVA), and an Input Board Assembly. The Ni^{63} switch of concern is part of the FTS HVA. The HVA provides the alternating current voltage step-up and gap switch trigger functions for the firing unit (Figure 1-4). The firing units are mounted in the raceways of each GBI booster motor (Figure 1-5). The FTS is discussed in greater detail in Appendix A.

The firing unit's HVA, each containing a Ni^{63} switch subassembly, will be obtained from existing Navy Trident Destruct Initiation Units. The switch is a two-electrode, gas-filled, ceramic and metal, hermetically sealed electron tube designed to operate in an arc discharge mode (Figure 1-6). It conducts moderate to high peak currents for very short time durations.

The radiation source parts within these switches are in the form of plated anode and cathode electrodes. The radioactive substance used in these devices is Ni^{63}, a pure, beta-emitting isotope with a half-life of 85 years. The Ni^{63} is in the form of metallic nickel, and has been electro-plated on the inter-space surface of the electrode base material in a barrel plating process. The total calculated deposition of Ni^{63} in any one device is 40.0 microcuries. Each firing unit makes use of one switch; each of the two booster motors contains two firing units.

1.4.2 Location of Activities

The HVA containing the Ni^{63} switch will be integrated into the new firing unit at Lockheed Missiles and Space Company (LMSC) in Sunnyvale, California. The firing unit is assembled and tested at LMSC facilities prior to shipment to USAKA.



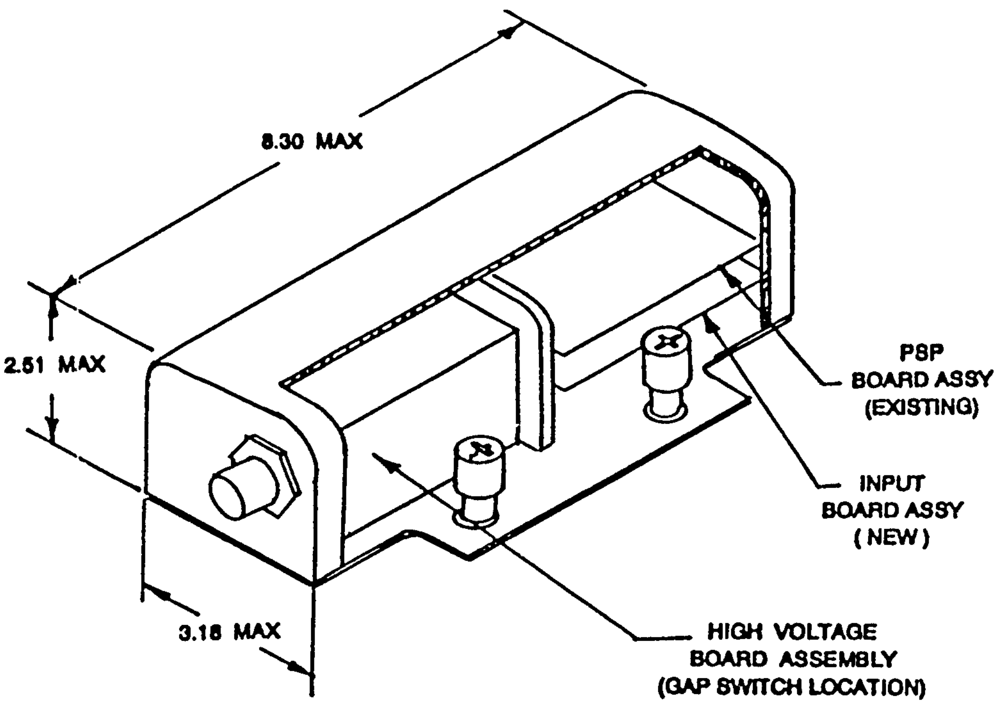
GBI FLIGHT SAFETY CORRIDOR

NOTE:
AS THE DISTANCE FROM THE NOMINAL FLIGHT TRAJECTORY INCREASES, THE IMPACT PROBABILITY DECREASES.

NORTH

0 50 100 200
MILES
1^{o} LATITUDE = 60 NM

Figure 1-3



FTS

FIRING

UNIT

EXPLANATION:

CASE: ALUMINUM 1.6mm (1/16") THICK

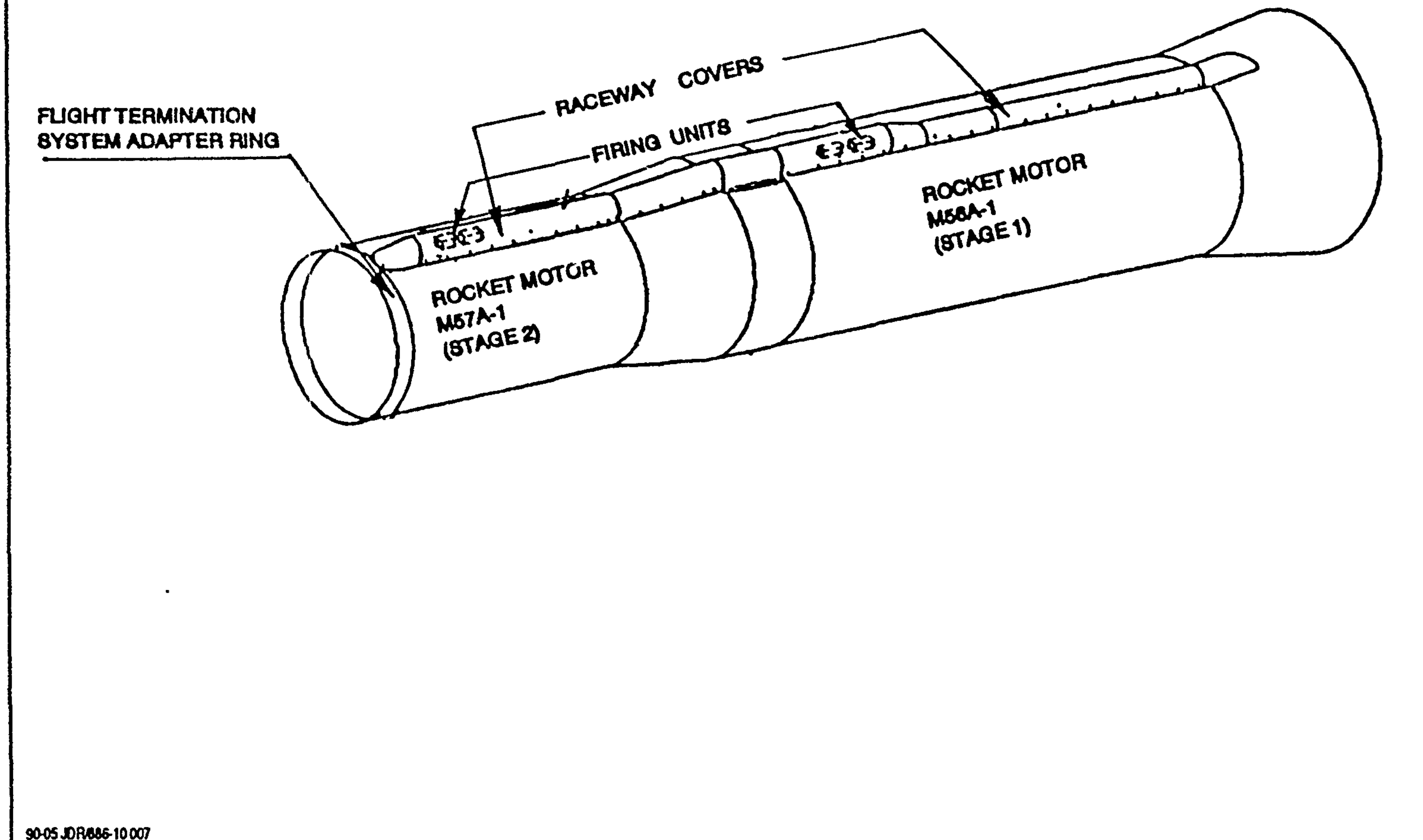
CASE BASE: 4.8mm (3/16")

CASE INTERIOR: POLYSTYRENE FOAM 6 lb/ft^3 DENSITY

BOARD ASSEMBLY: FIBERGLASS AND PHENOLIC 1.6mm (1/16") THICK

NOT TO SCALE
DIMENSIONS ON SKETCH
IN INCHES

Figure 1 - 4



FLIGHT TERMINATION AND GBI BOOSTER SYSTEM

GBI STAGE II
LENGTH: 85.9in
DIAMETER 37.8 in
WEIGHT 4481 lb

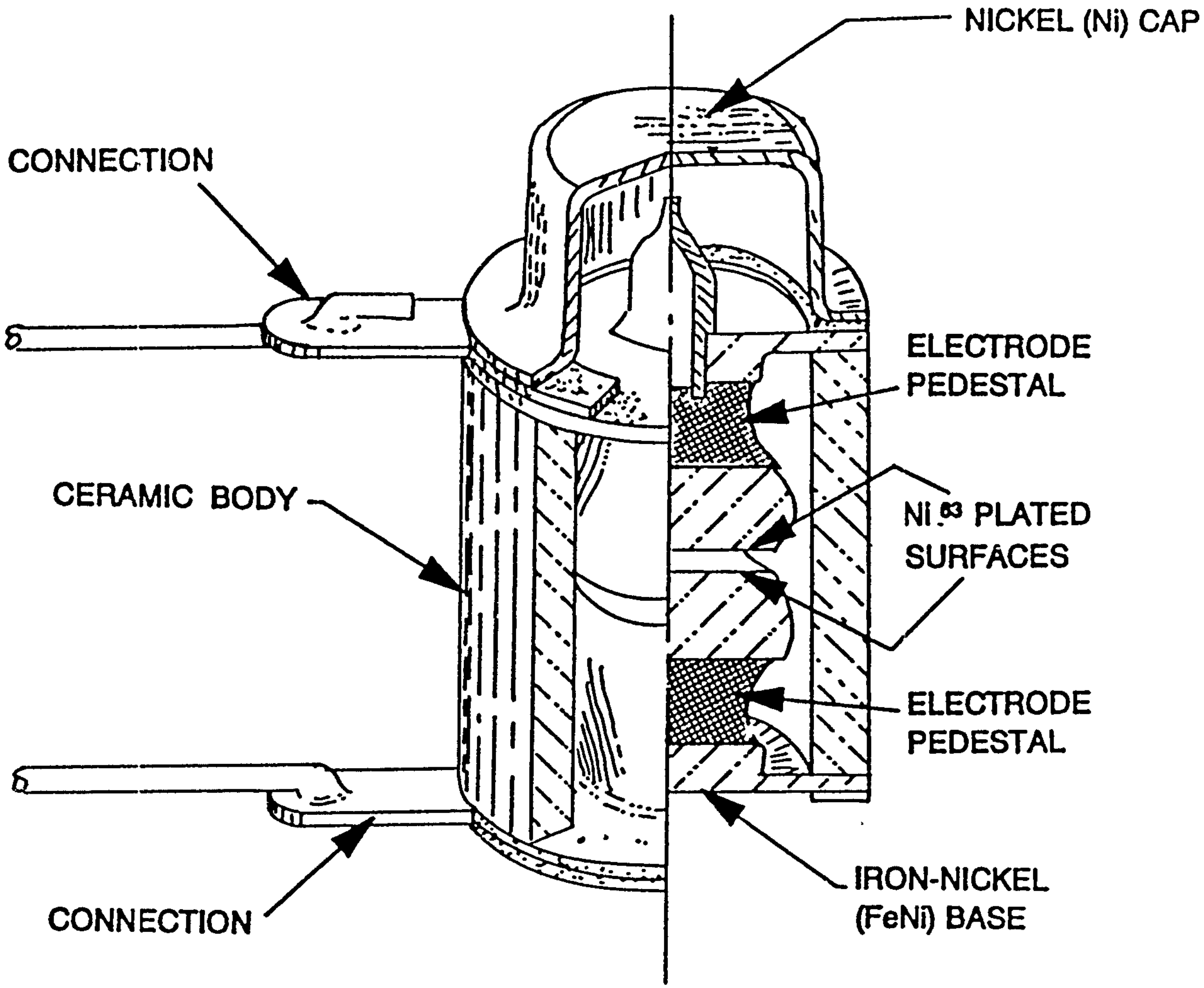
GBI STAGE I
LENGTH 150.1 in
DIAMETER 44.7 in
WEIGHT 11,873 lb

OVERALL
LENGTH 236 in
(19ft 7in)
WEIGHT 16,354 lb

NOT TO SCALE

Figure 1 - 5

Ni ^{63} OVERVOLTAGE GAP SWITCH



DIMENSIONS:

Height: = 13.3 mm (0.525 in.)
Diameter: = 8.26 mm (0.325 in)
Weight: 2.4 gms (0.08 oz.)

NOT TO SCALE

Figure 1 - 6

The new firing units are sent to Meck Island (USAKA), where they are installed on the GBI booster along with the destruct ordnance used in the FTS. This installation takes place in the missile assembly building prior to movement to the launch pad silo. The arming of the destruct initiator will only be conducted in the launch pad silo, just prior to launch.

Appropriate safety measures will be used during handling and storage of the Ni^{63} switches, as required by the USAKA Range Safety Manual, LMSC Radiation Protection Procedures, and the Nuclear Regulatory Commission (NRC) requirements under Title 10, Code of Federal Regulations (CFR), "Energy."

During a normal flight, the first and second stage boosters, each containing two switches, will fall intact into the broad ocean area (Figure 1-3). The switches have been shock-, thermal-, and vibration-tested to levels in excess of normal launch stress factors (Mercado, 1990).

In the event of a flight termination action, the motor casing of the boosters will be split lengthwise, which will terminate thrust, causing the boosters to fall through the atmosphere into the broad ocean area.

1.5 Alternatives Other than the Proposed Action

Two alternatives to the proposed action were considered, but have been rejected as unreasonable. The first alternative was to develop a new non-radioactive firing unit. This alternative was determined to be unreasonable because it would cause an unacceptable delay in the GBI program schedule. The second alternative considered was to launch without an FTS. This alternative was rejected as unreasonable because of the unacceptable risk to personnel and property.

1.6 No-Action Alternative

The no-action alternative is to continue to use the EFI. This alternative would result in potential significant hazards to personnel, which would not be permitted by range safety. Therefore, the GBI program would not be allowed to launch, resulting in the inability to conduct the GBI program and to resolve technical issues critical to the formulation of the SDS architecture.

2.0 AFFECTED ENVIRONMENT

2.1 Lockheed Missiles and Space Company (LMSC)

The LMSC's GBI facilities are located in Sunnyvale, California. Within this area, the Ni^{63} switch will be received, assembled into the FTS, and put through acceptance and integration tests. These existing facilities were originally built for a previous program and can be used to complete all proposed analyses, simulations, and component/assembly tests for the GBI program. All activities associated with Ni^{63} will occur in selected existing buildings within the Lockheed Complex, in accordance with LMSC radiation protection procedures (LMSC, 1990b). LMSC obtained required federal, state, and local permits and authorizations for the use of the radioactive Ni^{63}. A permit from the City of Sunnyvale is presently being issued. All operations and handling of the Ni^{63} will be in accordance with radioactive requirements as stated in the required permits and authorizations. The facilities involved are in a fully developed industrialized area and no significant cultural or natural resources are known to be present within the complex. Approximately 23,000 people are employed at the Sunnyvale facilities, of which 100 to 150 people are involved in manufacturing, assembly, and testing the GBI including the FTS.

2.2 U.S. Army Kwajalein Atoll (USAKA)

The primary mission of USAKA is to support missile flight testing for DOD research and development efforts. Technical facilities on USAKA include multiple launch facilities and numerous supporting elements, such as tracking radar, optical instrumentation, satellite communications, and telemetry stations (USASDC, 1988; 1989a,b).

USAKA is within the Ralik Chain in the western portion of the Marshall Islands, in the west-central Pacific Ocean southwest of Hawaii. The Marshall Islands were previously administered by the United States under a strategic trust established by the United Nations (Office of Micronesian Status Negotiations, 1984). The Compact of Free Association (Compact) between the United States and the Republic of the Marshall Islands (U.S. Public Law 99-239) was bilaterally implemented by the signatories on October 21, 1986. The Compact created the sovereign nation of the Republic of the Marshall Islands. The United States, in the conduct of its activities in the Marshall Islands, applies standards substantively similar to U.S. environmental standards, until alternate standards that are fully protective of health, safety, and the environment are developed in consultation with the Republic of the Marshall Islands and the EPA, as envisioned in Section 161 of the Compact (USASDC, 1989a,b).

Kwajalein Atoll consists of a very large interior lagoon [2,850 square kilometers (1,100 square miles)] surrounded by approximately 100 component islands/islets. USAKA includes 11 leased islands (Kwajalein, Roi-Namur, Ennylabegan, Meck, Gagan, Gellinam, Omelek, Eniwetak, Legan, Ennugarret, and Illeginni). All USAKA-leased islands, except Ennugarret, have facilities. United States citizens live on Kwajalein and Roi-Namur islands. The Marshallese residents live on, or use, several islands outside the mid-atoll corridor. The various resource elements comprising the existing environment at USAKA are described in detail in the USAKA EIS (USASDC, 1989a,b).

3.0 ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED ACTION

Ni^{63} produces beta radiation with a maximum energy of 0.067 million electron volts (MeV) for the electrons. Beta radiation is generally low penetrating and the low energy level of 0.067 MeV is particularly short range (Appendix A). Calculations (Appendix A) indicate that it will only penetrate about two thousandths of an inch or a third of the thickness of human skin (USDHEW, 1970). By comparison, paper has the thickness of several thousandths of an inch.

Various allowable levels have been published by regulatory agencies to limit releases of radioactive materials into the environment. The maximum allowable dosage per year is 0.5 REMs (USDHEW, 1970). A REM, a Roentgen Equivalent Man, is a measure of radiation dose based on the ionizing radiation required to produce the same biological effect in man as one roentgen of high penetration x-rays.

Calculations based on published data (USDHEW, 1970) indicate that if all the radioisotope material from a single switch was ingested or inhaled by a person, the retained material would produce a dosage in a one year period of 0.09 REM (Appendix A). This value is well below the maximum allowable dosage per year of 0.5 REM. Approximately two-thirds of any amount of Ni^{63} ingested or inhaled is excreted immediately (ICRP-30, 1978). The maximum attainable exposure, therefore, originates from one-third of the Ni^{63} in the switch that was ingested or inhaled. In terms of cancer risk, the 0.09 REM is equivalent to smoking 18 cigarettes per year (Beckmann, 1979). This low level will not represent a hazard to human or marine life, and, therefore, there is no significant impact related to the use of these switches during a terminated flight.

The Environmental Protection Agency (EPA) concentration level of Environmental Compliance (FR, December, 1989) for Ni^{63} in air is 1.4×10^{-5} microcuries per m^3. The corresponding level (10 CFR 20, 1989) for Ni^{63} in water is 3×10^{-5} microcuries per milliliter. These values are the accepted limits for concentrations of Ni^{63} in the water and air.

The switches undergo an extensive testing program to ensure their integrity. Completed Ni^{63} switches are designed, and have been shock tested, to withstand more than 3,500 times the force due to the acceleration of gravity (g) in 0.5 millisecond pulses, in each of six perpendicular directions. The switches withstand a thermal shock of plunging from water at 97 degrees C into a supercooled (-55 degrees C) fluorinert and again into 97 degrees C water for five cycles. The switches have also been vibration tested for 10 minutes with a constant power spectral density of 0.6 g^2/Hz with no effect on operations (Mercado, 1990).

3.1 Lockheed Missiles and Space Company (LMSC)

The FTS will be assembled and tested within the LMSC facilities. LMSC obtained the required federal, state, and local permits and authorizations for the use of the radioisotope Ni^{63}. All operations and handling of the Ni^{63} will be in accordance with radioactive requirements as stated in the required permits and authorizations. No additional personnel would be assigned to the existing GBI workforce as a result of the change in switches. The existing social and utility infrastructure is adequate to meet requirements of LMSC. Therefore, there are no significant environmental consequences from the proposed actions at LMSC.

3.2 U.S. Army Kwajalein Atoll (USAKA)

Environmental Consequences of the proposed actions at USAKA are related to the results of a nominal or terminated flight and are also consistent with Section 314 of the Compact of Free Association, Public Law 99-239 (CFA, 1986).

3.2.1 Consequences of a Nominal Flight

During a nominal flight, there will be no dispersion of debris from the spent motor casings or the firing units. The normal sequence of events will be the separation of the rocket stages resulting in the deposition into the broad ocean area (international and not territorial waters) of two intact rocket casings, along with the fully enclosed Ni^{63} switches. The integrity of the switches is such that this impact would not normally result in rupture of the switches. The approximate nominal impact areas (Figure 1-3) are described below:

First stage:	73 nmi from launch point; major axis - 50 nmi; minor axis - 10 nmi.
Second stage:	786 nmi from launch point; major axis - 9.2 nmi; minor axis - 6 nmi.

The burned out second stage will reenter the atmosphere in the nominal case. There is a remote chance that heating during reentry may result in aerothermal burnup. The potential pulverization of the switches due to aerothermal burnup is discussed in section 3.2.2.

In the case of a nominal flight, the product specification tests firmly support the expectation that the four Ni^{63} switches on a vehicle will remain intact for the complete mission. Calculations based on published data (USDHEW, 1970) indicate that radiation with the energy of the beta particles from Ni^{63} can only penetrate a few ten-thousandths of an inch into the walls of the switch (Appendix A).

After a nominal flight, the booster casing will descend to the bottom of the ocean. Corrosion of the switch enclosure in salt water will occur over a period of time (approximately 80 years) (Appendix A). After this has occurred, the Ni^{63} corrodes over a three-day period and would have a negligible effect upon the organisms present at the bottom of the ocean due to the decrease in activity by almost one-half after 80 years.

3.2.2 Consequences of a Terminated Flight

If it is necessary to terminate a flight, the command destruct system will be activated. As a result of this action, debris will be generated from the rocket motor and payload material. The first stage motor with its fuel will burn intensely, but the second stage motor could explode due to its high energy propellant. As described in Section 1.4.1, an explosive charge is the element of the FTS that effects the termination of motor thrust. The linear shaped explosive charge will be directed inward, splitting the case of each motor. The firing unit with its overvoltage gap switch is located in the raceway above the linear shaped charge. Therefore, the unit is in a lower explosive force region. In addition, the switches are located inside an aluminum case [1.6 mm (1/16") thick] surrounded by shock-mitigating plastic foam, enclosed by a mounting box and grouped with a number of components on a fiberglass/phenolic circuit board (Figure 1-4). All of these features

surrounding the switches reduce the likelihood of the switches being damaged and provide extra protection against radiation leakage. Furthermore, the process of terminating launch will allow the exhaust gases to disperse in all directions. Estimates of the shock forces and empirical evidence indicate that, in the event of a terminated flight, the Ni^{63} switches will remain intact. During the development phase of the Navy's Trident program, some boosters experienced inflight destruction. None of the Ni^{63} switches recovered exhibited signs of damage.

3.2.2.1 Pad Explosion

If the switches fragment due to inadvertent or intentional booster explosion in the silo or just above the launch pad, the scenario evaluated would be complete pulverization of the switches. The resulting expanding cloud of pulverized material would dilute the levels of radioactive substances to below allowable release limits before reaching any personnel. Calculations based on recently published EPA Concentration Levels for Environmental Compliance indicate that when the spherical cloud of Ni^{63} reaches a radius of about 140m (460 ft), the concentration level for the Ni^{63} falls below the compliance level (FR, December, 1989) of 1.4 x 10^{-5} microcuries per m^3. This value occurs well within the established Explosive Safety Quantity Distance (ESQD) of 381m (1,250 ft) (Figure 1-7). All unauthorized personnel are prohibited from being in the ESQD during launch. Since adequate dilution would take place within the ESQD, any radioactive dust outside the ESQD would be below the allowable concentration levels. If the normal prevailing winds of approximately 16 miles per hour (USASDC, 1989a,b) are present, these winds would increase the atmospheric dispersion, further reducing the concentration.

If the fragmented Ni^{63} does not pulverize, then the fragments would be located with other booster debris within the 381m (1,250 ft) ESQD. If fragments can be located by using radiation detection survey equipment, they will be retrieved in accordance with ground safety procedures (LMSC, 1990a and USASDC, 1986) as revised (Williams, 1990).

Since the booster is launched from the silo, a pad explosion would result in flame and debris escaping through the silo top and the exhaust flame trench. The likelihood of debris falling into the lagoon is significantly reduced due to silo shielding.

3.2.2.2 Flight Termination

Flight termination can occur during two periods: before and after first stage separation. If flight termination occurs before first stage separation, there are three possible results: the switches come down intact with the boosters, the switches fragment, or the switches pulverize. The intact switches would descend to the bottom of the ocean, where corrosion would occur. This scenario is identical to the result of a nominal flight (Section 3.2.1), and no significant environmental impacts are expected.

If the switches fragment and drop to the bottom of the ocean, the Ni^{63} would disperse to below the acceptable limit (10 CFR 20, 1989) of 3 x 10^{-5} microcuries per milliliter after reaching a radius of approximately 1.1m (3.6 ft) (Appendix A) from the switch or fragment location. This value represents the release of 160 microcuries at a single instant into the ocean. In reality, the corrosion of the Ni^{63} would result in the microcuries being released over a three-day period

GBI LAUNCH PAD EXPLOSIVE SAFETY DISTANCE LOCATION

MECK ISLAND,
UNITED STATES ARMY
KWAJALEIN ATOLL

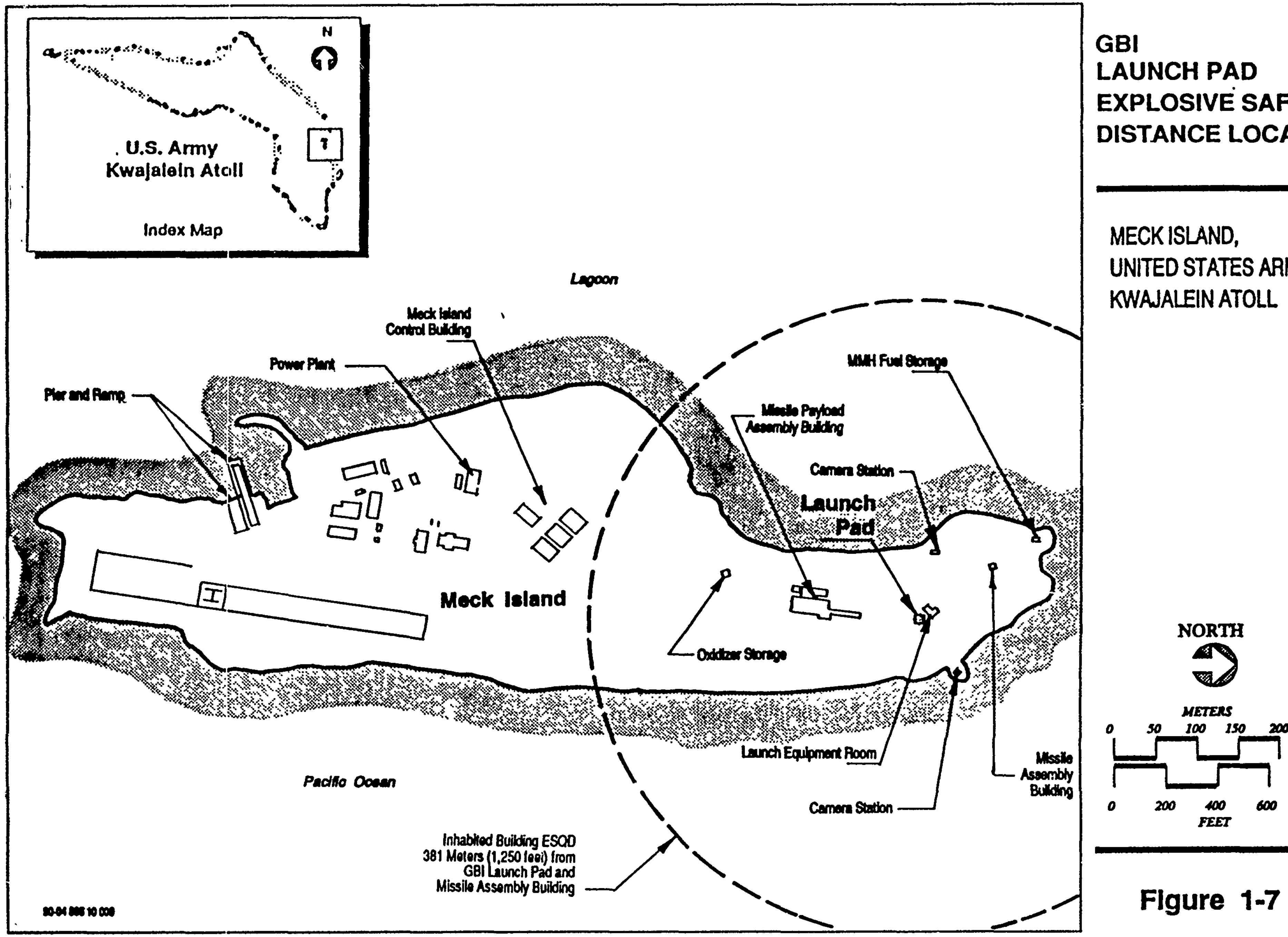


Figure 1-7

(Appendix A), reducing the volume of water needed to meet the allowable concentration limits. No significant environmental impacts would result from this level of release of Ni^{63}.

In the third scenario, all four switches would pulverize in the atmosphere and be dispersed. A calculation for the dispersal of pulverized switches (Appendix A) is based on a conservative set of parameters, including a steady state source that would release Ni^{63} well in excess of the 160 microcuries and termination at 8 km (5 mi) altitude with a 3.6 km/hr (2.2 mph) wind speed. The calculated level for Ni^{63} of 7.81×10^{-13} microcuries per m^3 in air falls below the compliance level (FR, December, 1989) of 1.4×10^{-5} microcuries per m^3 and would not result in significant environmental impacts.

Once a nominal first stage separation occurs, the two switches in the first stage would fall intact into the ocean as described in Section 3.2.1. For the second stage with the remaining 80 microcuries of Ni^{63}, the same three alternatives present themselves as described above. If, as a result of flight termination, switches fall intact into the ocean (Section 3.2.1), no significant environmental impacts are expected.

If the switches fragment and drop to the bottom of the ocean, the 80 microcuries of Ni^{63} would disperse to below the acceptable limit (10 CFR 20, 1989) of 3×10^{-5} microcuries per milliliter after reaching a radius of approximately 0.85m (2.8 ft)(Appendix A) from the switch or fragment location. This value is smaller than the previous value due to the lower quantity of Ni^{63}, and no significant environmental impacts are expected.

If two switches pulverize, the calculation, assuming a steady state source with 80 microcuries of Ni^{63}, gives a concentration level of 3.90×10^{-13} microcuries per m^3 (Appendix A). This value is due to the resulting dispersion from the explosion with winds present. With this level of Ni^{63} dispersion, no significant impacts are expected.

3.3 Environmental Consequences of the No-Action Alternative

If the no-action alternative is selected, the GBI project would continue to use the EFI and the booster would pose unacceptable personnel and property risks. No other environmental consequences are anticipated beyond those outlined in the ERIS EA (SDIO, 1987a).

3.4 Conflicts with Federal, Regional, State, Local, or Native American Tribal Land Use Plans, Policies, and Controls

Since all continental U.S. activities relative to use of the Ni^{63} switch will be carried out in existing facilities, no significant impacts are expected with regard to conflicts with federal, regional, state, local, or Native American tribal land use plans, policies, and controls.

3.5 Energy Requirements and Conservation Potential

The substitution of the Ni^{63} switches will have no significant effects on energy requirements and conservation potential. Neither the insignificant amounts of material involved nor the installation activities differ from those addressed for the earlier EFI switch design.

3.6 Natural or Depletable Resource Requirements

The small quantities of Ni^{63} and other materials used in the GBI FTS are not expected to significantly impact natural or depletable resources, because of the insignificant amounts of material involved.

3.7 Adverse Environmental Effects That Cannot Be Avoided

There would be no significant adverse environmental effects associated with the use of Ni^{63} switches that could not be avoided.

3.8 Relationship between Short-Term Uses of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity

The use of Ni^{63} switches will have no significant effect on the short-term use of man's environment nor on the maintenance and enhancement of long-term productivity of the natural systems affected.

3.9 Irreversible or Irretrievable Commitment of Resources

There will be no irreversible or irretrievable commitments of significant resources as a result of the use of Ni^{63} switches.

4.0 GLOSSARY

C	Centigrade
CFR	Code of Federal Regulations
Compact	The Compact of Free Association
Curie	A special unit of radioactivity. One curie equals 3.7 x 10^{10} disintegrations per second.
DOD	Department of Defense
DOPAA	Description of Proposed Action and Alternatives
EFI	Exploding Foil Initiator
Environmental Assessment (EA)	A concise public document in which a Federal agency provides sufficient analysis and evidence for determining the need for an Environmental Impact Statement (EIS) or Finding of No Significant Impact (FNSI). EAs provide agencies with useful data regarding compliance with the NEPA and are an aid in the preparation of an EIS.
Environmental Impact Statement (EIS)	A detailed analysis of environmental aspects of a proposed project that is anticipated to have a significant effect on the human environment.
EPA	Environmental Protection Agency
ERIS	Exoatmospheric Reentry Vehicle Interception System; also known as Exoatmospheric Reentry Vehicle Interceptor Subsystem.
ESQD	Explosive Safety Quantity Distance
Exoatmosphere	Outside the Earth's atmosphere; generally considered to be altitudes above 100 kilometers (62 miles).
FNSI	Finding of No Significant Impact
ft	feet
FTS	Flight Termination System

g	A unit of force equal to the force exerted by gravity near the earth's surface to indicate the force to which a body is subjected when accelerated.
GBI	Ground-Based Interceptor
g^2/Hz	g^2/Hertz; unit used for power density.
HVA	High Voltage Assembly
Hz	Hertz is a unit of frequency equal to one cycle per second.
Impact	An assessment of the meaning of changes in all attributes being studied for a given resource; an aggregation of all the adverse effects, usually measured by a qualitative and nominally subjective technique.
km	kilometer
km/hr	kilometer per hour
LMSC	Lockheed Missiles and Space Company, Inc.
m	meter
MeV	Million Electron Volts
mi	mile
Microcurie	One-millionth of a curie (3.7 x 10^4 disintegrations per second).
mm	millimeter (one-thousandth of a meter)
mph	miles per hour
NEPA	National Environmental Policy Act
Ni^{63}	Nickel radioisotope with a half life of 85 years and a maximum of 0.067 MeV beta particle energy.
NRC	Nuclear Regulatory Commission
Reentry vehicle	The missile portion containing the payload. It is released from the last stage of a booster rocket or from a post-boost vehicle in a ballistic trajectory and is designed to reenter the earth's atmosphere in the terminal position of the trajectory.

REM	Acronym for roentgen equivalent in man. A unit for measuring a dose of radiation. A REM is equivalent to the amount of ionizing radiation required to produce the same biological effect in man as one roentgen of high-penetration x-rays.
RMI	Republic of the Marshall Islands
SDI	Strategic Defense Initiative
SDIO	Strategic Defense Initiative Organization
SDS	Strategic Defense System
Trajectory	The curved path of an object hurtling through space, especially that of a projectile, from the time it is launched.
U.S.	United States
USAKA	U.S. Army Kwajalein Atoll
USASDC	U.S. Army Strategic Defense Command

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APPENDIX A

USE OF Ni^{63} OVERVOLTAGE GAP SWITCH ASSESSMENT TECHNICAL REPORT

APPENDIX A
TECHNICAL REPORT

FIGURES

<u>**FIGURES**</u>
(Continued)

APPENDIX A
Ni^{63} OVERVOLTAGE GAP SWITCH ASSESSMENT TECHNICAL REPORT

1.0 INTRODUCTION

This Technical Report provides supportive information, data, and details for the technical conclusions presented in the Environmental Assessment (EA), "Use of Ni^{63} Overvoltage Gap Switches in the Flight Termination Systems on Boosters Launched from U.S. Army Kwajalein Atoll (USAKA)." The sequence of events leading to the selection of a Flight Termination System (FTS) that makes use of a Nickel radioisotope (Ni^{63}) overvoltage gap switch(es) is presented. Details of the design, operation, specifications, production, acceptance tests, and the nuclear radiation data for the switch are described. Finally, the sequences of the various possible scenarios that may result from the use of the switches are discussed.

2.0 BACKGROUND OF Ni^{63} OVERVOLTAGE GAP SWITCH ADOPTION

When a prototype of the initial Ground Based Interceptor (GBI) firing unit (the Explosive Foil Initiator) was built and tested, it operated unreliably. Many hardware development problems were encountered in developing a new firing unit. At that time, the GBI program requirements of reliability and schedules precluded further efforts to develop a new firing unit.

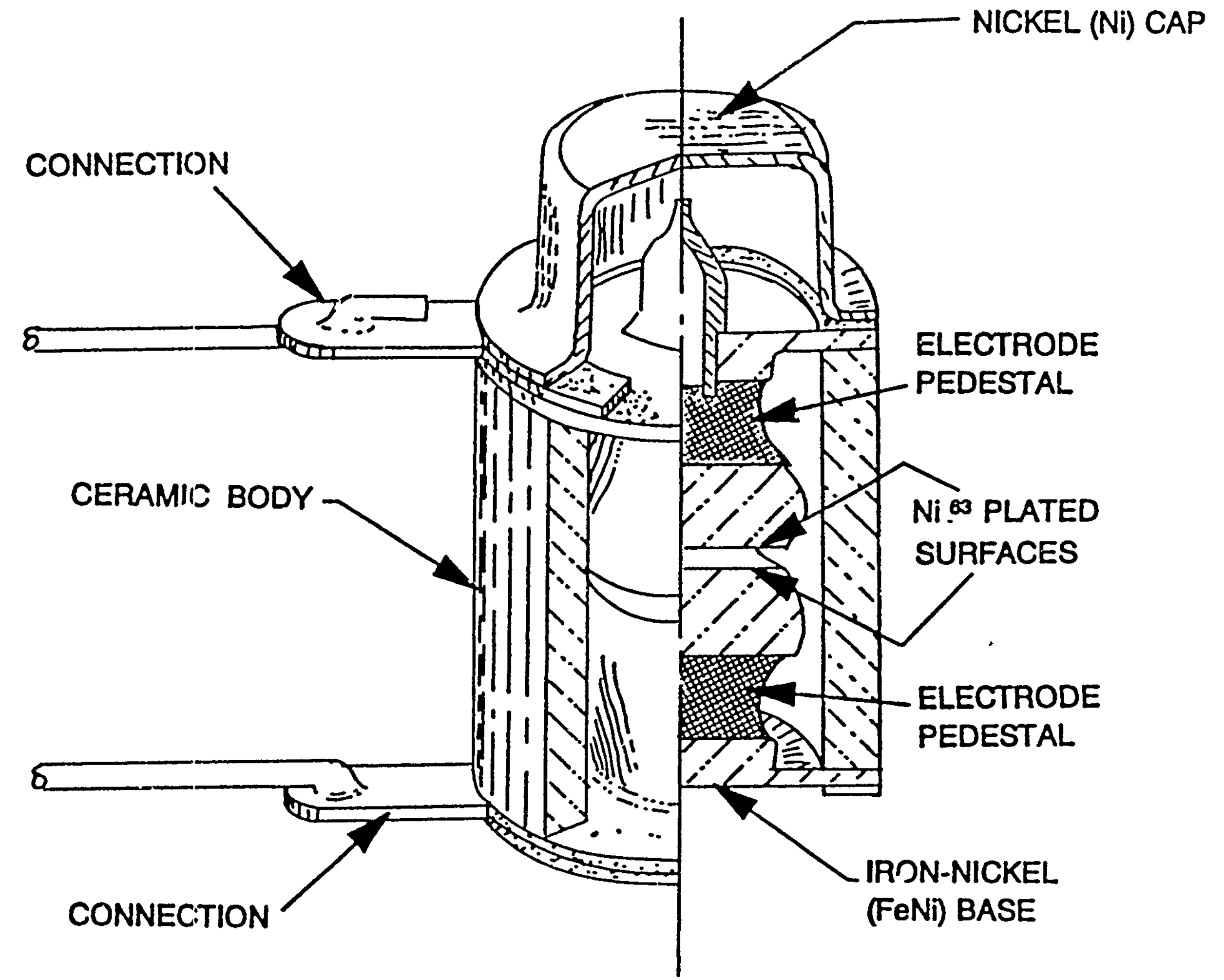
A subsystem, used for flight termination aboard the U.S. Navy's Trident missile was found to be operationally suitable for use in the GBI FTS. The Trident System contains a firing unit with a radioactive switch that has electrodes plated with a thin layer of metallic Ni^{63} isotope. The component contains argon gas that is continuously ionized by the beta particles emitted by the Ni^{63} into the space between the electrodes (Figure A-1). This ion cloud allows consistent current initiation when a high voltage pulse is applied to the electrodes.

The Trident firing unit was adapted to the GBI vehicle with minimal redesign. Specifically, the High Voltage Assembly (HVA) circuit boards (with their various components in place, including the Ni^{63} switch) were integrated into the new firing unit. In this way, both scheduling and operational requirements were met. The firing unit consists of three segments, the Premature Separation Module, the Trigger Circuit, and the HVA (Figure A-2). A photo of the GBI vehicle's second stage with firing units attached is shown in Figure A-3.

The integration of the FTS into the GBI vehicle follows the following sequence (Mercado, 1990a):

- The Destruct Initiation Unit (DIU) to be used for the subsystems is obtained from the Navy.

- The necessary parts (HVA) are removed from the DIU and integrated into the new GBI firing unit.



Ni ^{63} OVERVOLTAGE GAP SWITCH

DIMENSIONS:

Height: ≈ 13.3 mm (0.525 in.)
Diameter: ≈ 8.26 mm (0.325 in)
Weight: 2.4 gms (0.08 oz.)

NOT TO SCALE

Figure A - 1

FTS
FIRING
UNIT

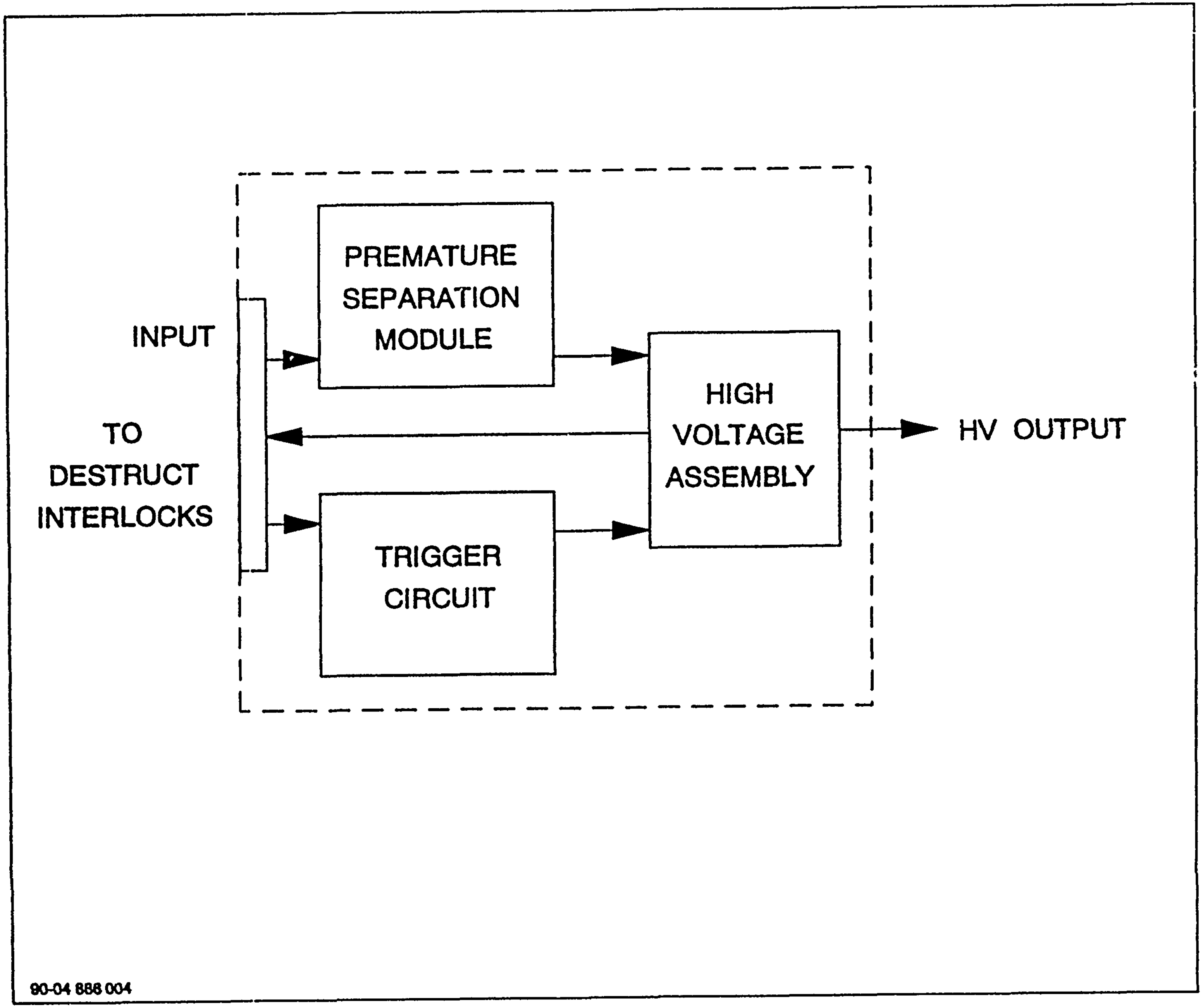


Figure A-2

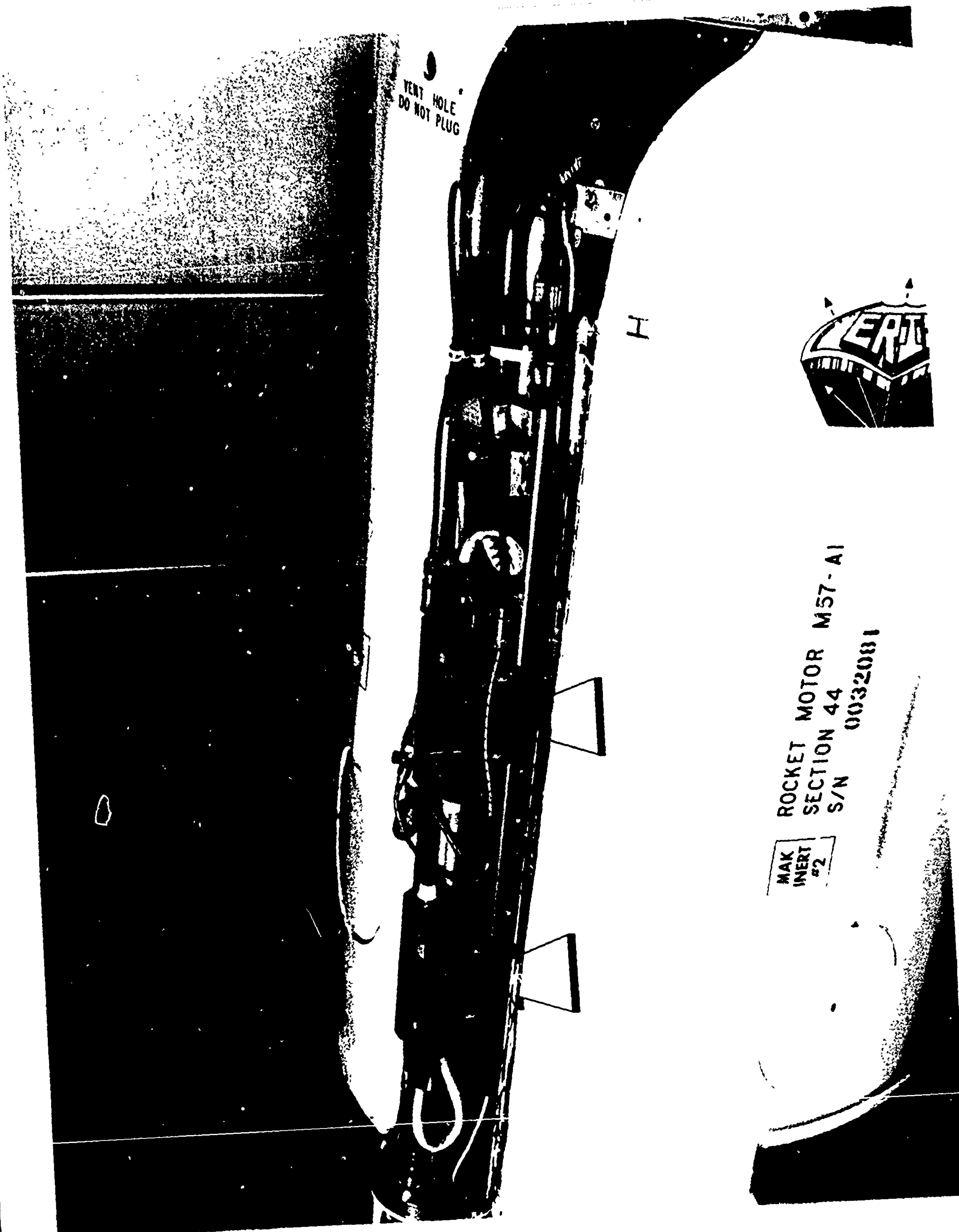


Figure A-3
FTS Firing Units

- The firing unit is bench tested, installed into the FTS, and subsystem tested for proper operation.

- The FTS is installed into the GBI vehicle.

These activities are conducted at the Lockheed Missiles and Space Company (LMSC) facilities, Sunnyvale, California, and at Meck Island, USAKA.

3.0 Ni^{63} OVERVOLTAGE GAP SWITCH PRODUCT SPECIFICATIONS

The Ni^{63} switch is manufactured by EG&G, Inc., of 35 Congress Street, Salem, Massachusetts 01970 (J. Suty, Pers. Comm., 1990). It is labelled Tube Type EGG328986. The isotope is metallic Ni^{63}, which is plated onto the electrodes (Figure A-1) by New England Nuclear Corporation of Boston. The total deposition in a single device is 40.0 microcuries. The Ni^{63} switch was designed and developed by Sandia National Laboratories (SNL), Albuquerque, New Mexico. The Ni^{63} switch is used in many applications, in addition to the Trident and GBI programs. SNL established the product acceptance specifications and supervises the manufacture of the product by EG&G.

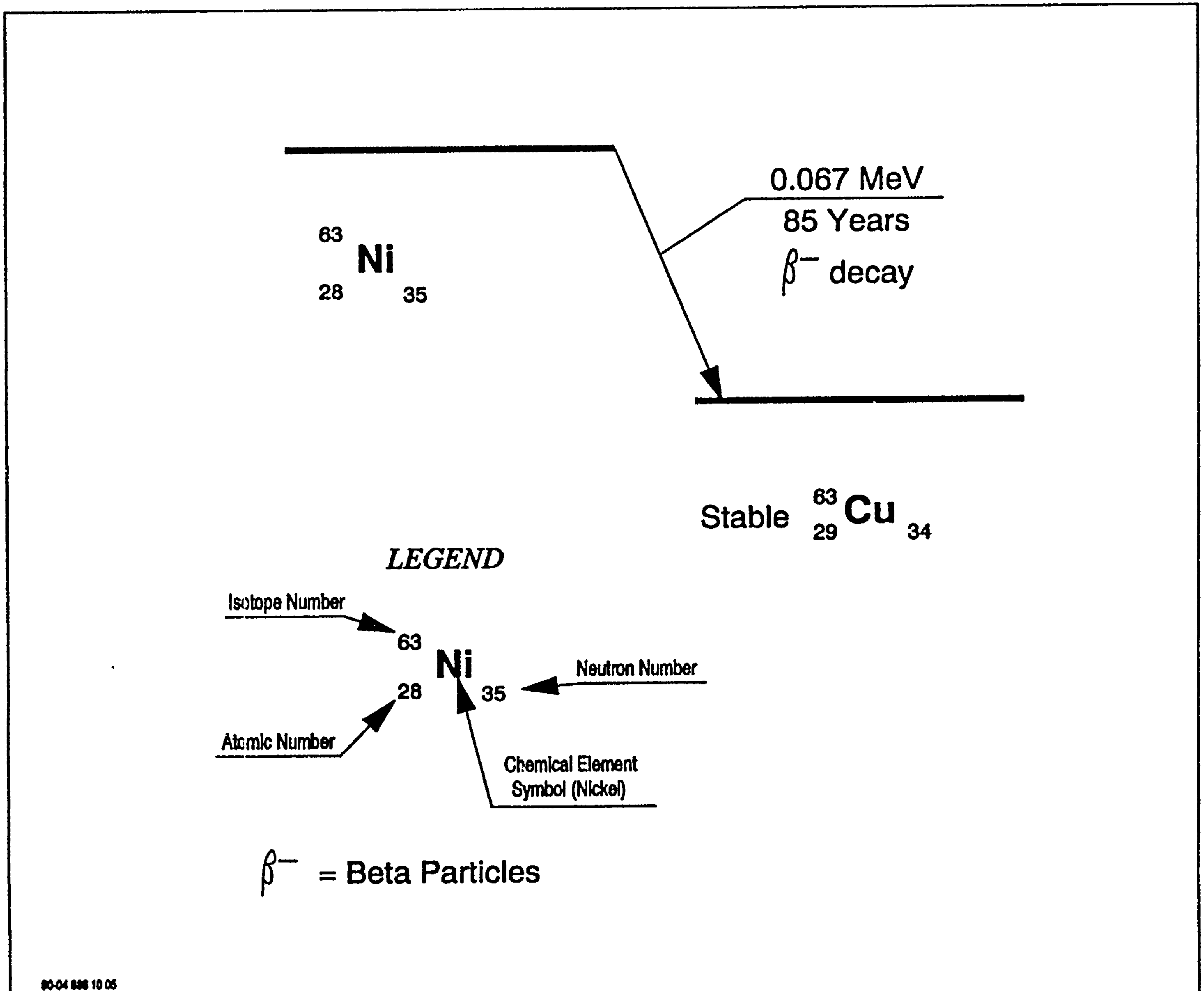
In its essential features, the Ni^{63} switch (Figure A-1) consists of a ceramic cylinder, approximately nine millimeters (one-third inch) in diameter with a wall thickness of approximately one millimeter (0.04 inches). One end is a flat, iron-nickel surface; the other has a nickel cap. Two lateral electrical wires connect to the cylinder. Its overall length is about 13 millimeters (one-half inch). It is filled with argon gas and is imprinted with an Occupational Safety and Health Administration (OSHA) Standard Radiation Warning Label.

During development, models of the switch were tested at SNL up to a hydrostatic pressure of 20,000 pounds per square inch (psi) (Soutar, 1990). Test specifications established by SNL are carried out by EG&G on samples from all production batches of the switch. The tests include: 1) misfire resistance under a series of high voltage pulses (up to 1,500 volts); 2) temperature cycles with a variation from 97°C to -55°C, and quickly returned by plunging from one bath to the other (15 second soak time); 3) mechanical shock of 3,500 g intensity and one-half thousandth second duration, in each of six perpendicular directions; and 4) random vibration, with a constant power density of 0.6 g^2/Hz, ranging across the vibration spectrum from 50 Hz to 3,000 Hz, in each of three perpendicular directions.

4.0 Ni^{63} NUCLEAR DECAY SCHEME

The relevant nuclear properties of Ni^{63} are shown through the use of a diagram called a Nuclear Decay Scheme (Figure A-4). As shown in the diagram, the isotope emits beta particles (which is the process of beta decay) with a maximum energy of 0.067 million electron volts (MeV) and a half-life of 85 years (ORNL, 1973). This process results in the transformation of atoms of radioactive nickel into non-radioactive copper.

The energy of the Ni^{63} beta particles is relatively low. Most beta particles emitted by various radioactive isotopes have considerably more energy, with many having energies greater than 1.0 MeV. For a radioisotope to have a half-life of 85 years means that a radiation activity of 40 microcuries at the present time will decay to 20 microcuries in 85 years.



Ni^{63} NUCLEAR DECAY SCHEME

Figure A - 4

5.0 GENERAL BETA PARTICLE KINETICS

5.1 Range of Beta Particles

The energy of the beta particles is fundamental to their ability to penetrate, which is called the range. The mathematical equation used to calculate this quantity (USDHEW, 1970) is:

$$R = 412\ E^{1.265 - 0.0954 \ln E}$$

$$\text{FOR } 0.01 \text{ MeV} \leq E \leq 2.5 \text{ MeV}$$

WHERE:

R = RANGE IN mg/cm ^{2}
E = MAX. β ENERGY (MeV)

Applying the beta particle energy of $E = 0.067$ MeV, $R = 412\ (0.067\ \text{MeV})^{1.265 - 0.0954 \ln 0.067\ \text{MeV}}$, or $R = 6.7$ mg/cm^2.

The value of the range, in this form, permits the calculation of the distance travelled in any material by dividing the above result by the density of the material. For ceramic, the density is approximately 4500 mg/cm^3. Therefore:

$$R_{cer} = \frac{6.7\ \text{mg/cm}^2}{4500\ \text{mg/cm}^3} = 0.0015\ \text{cm}\ (0.0006\ \text{inches})$$

For air, the density is 1.293 mg/cm^3. Therefore:

$$R_{air} = \frac{6.7\ \text{mg/cm}^2}{1.293\ \text{mg/cm}^3} = 5.18\ \text{cm}\ (2.04\ \text{inches})$$

For skin, the thickness is about 0.018 cm and the density is approximately 1560 mg/cm^3 (Mader, 1985, USDHEW, 1970). Therefore:

$$R_{skin} = \frac{6.7\ \text{mg/cm}^2}{1560\ \text{mg/cm}^3} = 0.0043\ \text{cm}\ (0.0017\ \text{inches})$$

For water, the density is approximately 1000 mg/cm^3. Therefore:

$$R_{water} = \frac{6.7\ \text{mg/cm}^2}{1000\ \text{mg/cm}^3} = 0.0067\ \text{cm}\ (0.0026\ \text{inches})$$

Finally, the switch cap is made of ordinary nickel. Nickel has a density of 8900 mg/cm^3. Therefore, the range of beta particles into the switch cap is:

$$R_{Ni} = \frac{6.7 \text{ mg/cm}^2}{8900 \text{ mg/cm}^3} = 0.00075 \text{ cm (0.0003 inches)}$$

From these foregoing calculations, it can be concluded that the beta radiation cannot penetrate the walls of an intact Ni^{63} switch. In addition, if a switch is fragmented or pulverized, proximate exposure to the isotope material is limited to an air distance of about two inches and a water distance of 0.0026 inches. Finally, direct deposition of the isotope metal on the skin is also innocuous, since the beta radiation cannot penetrate the human skin. In conclusion, biological damage can only result through Ni^{63} intake (i.e., ingestion or inhalation).

5.2 Radiation Dosage

In the case of a single-event intake (ingestion or inhalation) of Ni^{63}, a calculation may be made that indicates exposure of an individual to the Ni^{63} radiation. This exposure dosage is calculated using the following equation (USDHEW, 1970):

$$D = 73.8 \; E \; T_{eff} \; C \; (1-e^{-\lambda_{eff} t})$$

WHERE:

D = BETA RADIATION DOSE (RADs)

E = AVERAGE ENERGY OF BETA PARTICLE RADIATION (MeV)

T_{eff} = EFFECTIVE HALF-LIFE (DAYS)

C = MICROCURIES PER gm OF TISSUE (MICROCURIES/gm)

t = EXPOSURE TIME (DAYS)

λ_{eff} = EFFECTIVE DECAY CONSTANT (DAY^{-1})

The calculation is based on a quantity called the effective half-life, (T_{eff}) (USDHEW, 1970). The biological half-life (T_b) is a measure of the time that metallic nickel remains in the body after intake. For nickel, it is found that two-thirds of the intake is excreted immediately (ICRP, 1978). The remaining one-third has a biological half-life of approximately 1,200 days. The effective half-life derives from the biological half-life and the radioactive half-life($T_{1/2}$). The effective half-life takes into account the significance of the exposure, based on both T_b and $T_{1/2}$.
These are combined in the following equations:

$$T_{eff} = \frac{(T_{1/2})\ (T_b)}{(T_{1/2}) + (T_b)}$$

$$\lambda_{eff} = \frac{0.693}{T_{eff}}$$

WHERE:

$T_{1/2}$ = RADIOACTIVE HALF-LIFE OF ISOTOPE (DAYS)
T_b = BIOLOGICAL HALF-LIFE IN THE BODY (DAYS)

When these equations are worked out using the appropriate data, the values of T_{eff} and λ_{eff} are obtained:

$$T_{eff} = \frac{(3.103 \times 10^4 \text{ DAYS})\ (1.2 \times 10^3 \text{ DAYS})}{(3.103 \times 10^4 \text{ DAYS}) + (1.2 \times 10^3 \text{ DAYS})} = 1155 \text{ DAYS}$$

$$\lambda_{eff} = \frac{0.693}{1155 \text{ DAYS}} = 0.000598 \text{ PER DAY} \approx 0.0006 \text{ PER DAY}$$

From these values and other required data (USDHEW, 1970), the radiation dose received by an individual after one year can be calculated from the dosage equation. Therefore:

t = one year (365 days)

E = 0.017 MeV (average)

$$C = \frac{40 \text{ microcuries}}{70000 \text{ gm (Standard Man.)}} = 0.00057 \text{ microcuries/gm}$$

$$D = 73.8\ (0.017 \text{ MeV})(0.00057 \text{ microcuries/gm})\ (1155 \text{ days})\ [1-e^{-(0.0006/day)(365\ days)}]$$

which results in:

D = 0.16 RADs.

This quantity is related to the annual exposure by the following relations (USDHEW, 1970):

Annual Exposure (REMs) = Dosage (RADs) x Q

where Q is a "quality factor" that depends upon the type and energy of the nuclear particle involved. For beta particles of average energy equal to 0.017 MeV, Q = 1.7 (USDHEW, 1970). Therefore, the calculated number, 0.16 RADs is converted to 0.27 REMs. Since only one-third

of the radioisotope remains in the body, the actual dosage is D = 0.27 REM/3 = 0.09 REM. Federal regulations limit the permissible annual exposure to 0.5 REM (10 CFR 20, 1989).

6.0 FLIGHT SCENARIOS

In order to analyze the risk to personnel and property, various considerations must be taken into account. First, there are three basic scenarios: 1) the test flight that takes place according to plan, a nominal flight; 2) a terminated flight that, nevertheless, results in the switch remaining intact; and 3) a terminated flight in which the switch is damaged. Secondly, some considerations apply to all of the scenarios. For example, the pathways by which the Ni^{63} can be a hazard will differ according to the scenario, but the actual potential damage mechanisms are essentially the same.

6.1 Nominal Flight

In a nominal flight, ground operations will be in accordance with ground safety procedures.

As discussed in Section 3.1 of the EA, the spent stages in the course of a nominal flight will be deposited in the broad ocean area. The switches will be enclosed in the spent booster sections and with shock resistance of 3,500 gs (SNL, 1990), the switches will remain intact. During development testing, the switch withstood pressures up to 20,000 psi. This data can be used to estimate the depth into the ocean to which it can descend without crushing: 34 feet of water depth corresponds to 14.7 psi. Therefore:

$$\text{Non-Crush Depth} = \frac{20000 \text{ psi}}{14.7 \text{ psi}} \times (34 \text{ feet}) = 4.6 \times 10^4 \text{ feet (8.8 miles)}$$

The broad ocean area off the USAKA ranges in depth from about 4.8 km (3 miles) to 5.6 km (3.5 miles) (DMA, 1986). Clearly, intact switches will not be crushed.

There is an unlikely possibility that the reentry of the booster second stage will result in aerothermal burnup. This could result in the pulverization of the switch. The material, at high altitudes, disperses readily, as indicated in the calculation of air concentrations in Section 6.3.

While the switches remain intact on the ocean bottom, at first the radioactive material will be unaffected. Sea water, however, affects most metals, including nickel; but it is considerably less reactive than various acids and, eventually, the metallic ends of the switches will corrode. The nickel electrodes will then begin to react with the sea water and diffuse while dissolving.

The corrosion rate of nickel in sea water is found to be 0.0025 mm/year (Shreir, 1977). The top cap of a switch is the thinnest metal possible exposed to the water. Its thickness is 0.2 mm. The time to penetrate through the cap is therefore:

$$\text{Time} = \frac{0.2 \text{ mm}}{0.0025 \text{ mm/yr}} = 80 \text{ years}$$

This would be the time for the cap to corrode and the radioactive electrode plating to be exposed to sea water and, in turn, dissolve. The time for the plating to dissolve will take approximately three days. The calculation is as follows (the plating thickness is 0.00002 mm):

$$\text{Time} = \frac{0.00002 \text{ mm}}{0.0025 \text{ mm/yr}} = 0.008 \text{ yr} = 2.9 \text{ days}$$

In addition, since Ni^{63} half life is 85 years, the remaining radioactivity after 80 years will be approximately one-half of the original activity.

The permissible concentration in water for Ni^{63} is 3×10^{-5} microcuries per cm^3 (10 CFR 20, 1989). While the dissolving process of the Ni^{63} must occur over a period of time, a worst-case assumption would be that the four switches corrode simultaneously and that the Ni^{63} emerges into the surrounding sea water without delay. In this sequence, the dispersion of the 160 microcuries (worst case) will decline to below the permissible concentration when the sphere of dispersed material reaches a radius 1.1 meters (3.6 ft) calculated as follows:

$$r = \sqrt[3]{\frac{3\ m}{4 \pi C}}$$

WHERE:

r = RADIUS OF SPHERE CONTAINING WATER COMPLIANCE CONCENTRATION
m = TOTAL MASS OF RADIOISOTOPE
C = LEVEL FOR WATER COMPLIANCE

USING THE APPROPRIATE DATA FOR WATER:

$$r = \left(\frac{(3) \quad 160 \text{ Microcuries}}{(4) \ (3.141) \ (30 \text{ Microcuries/m}^3)} \right)^{1/3} = 1.1 \text{ Meters} = 3.6 \text{ Feet}$$

Once first stage separation occurs, two of the switches are removed from consideration with the first stage booster. Based on the above calculations, if the switches fragment and drop to the bottom of the ocean, the 80 microcuries of Ni^{63} would disperse to below the acceptable limit (10 CFR 20, 1989) of 3×10^{-5} microcuries per milliliter after reaching a radius of approximately 0.85 meters (2.8 feet) from the switch or fragment location. This value is smaller than the previous value, due to the lower quantity of Ni^{63} and would in actuality be very much smaller because of the distance between fragments.

6.2 Destruction with Overvoltage Gap Switches Intact

The vehicle may inadvertently be terminated on the pad, or alternatively, be terminated by the range safety officer at any time from lift-off to burn-out: there are two possibilities considered for the purpose of this study. For the first possibility, in the event of destruction in the pad silo, the vehicle will remain within the pad area, or the winds may take some residual vehicle debris into the lagoon area. Intact switches may be deposited in the silo area, and may be retrieved and handled safely, in accordance with safety procedures. If retrieval efforts fail, the switches may

remain intact indefinitely and pose no hazard to personnel, the ecology, or property. The probability of residual debris falling into the lagoon, however, is 1×10^{-3} or less (SRS, 1989).

For the second possibility, termination will occur after lift off. During flight, the operational sequence for activating the FTS (Figures A-2 and A-3) to carry out a destruct action is:

- Alternating Current input voltage is stepped up to 3,400 volts and used to charge the High Voltage (HV) capacitor through a full-wave rectifier.

- The trigger transformer arcs across the Ni^{63} overvoltage gap switch after receiving a trigger signal.

- Switch arcing initiates the discharge of the HV capacitor across another (nonradioactive) switch to an ordnance detonator that initiates flight termination.

- The ordnance train ends at the linear shaped charge located along the length of each booster motor (Figures A-2 and A-3). The case of each motor is split open by the action of the charge and the internal pressure of the exhaust gases, which terminated thrust. The location of the firing unit subsystem is further away from the booster motor with respect to the linear shaped charge (Figures A-2 and A-3) and minimizes the effect of the explosive charge.

The debris produced by vehicle destruction, containing the intact switches, will splash down in the broad ocean area. Splash-down into a marine area will result in the sequence as described in Section 6.1, above.

6.3 Destruction with Overvoltage Gap Switches Damaged

In the event of overvoltage gap switch damage during ground or flight operations, fragmentation or pulverization may occur. Although no evidence exists to indicate that the switches can pulverize in the event of a terminated flight, calculations may be made to evaluate the effects of the particles, as a worst-case consideration.

6.3.1 Fragmentation

Physiological studies of inhalation of particles show that particles 10 micrometers in size or larger are trapped in the naso-pharyngeal area and promptly expelled (ICRP, 1978). While this effect cannot be calculated, the result would be to reduce the amount of particulate isotope inhaled. Therefore, the actual body absorption of radiation will be a fraction of the original amount of the isotope.

In the event of termination on the launch pad with the switches fragmented, they will be ejected into the immediate area. Fragments in the launch pad area may be located using radiation detection survey equipment and retrieved, in accordance with ground safety procedures.

The potential for intake of fragments of switches, again, is mitigated by several considerations. Vehicle destruction during boost could result in a wide dispersion of fragments in the atoll lagoon

or the broad ocean area. Intake by personnel would only be by ingestion along the food chain. Direct ingestion is extremely improbable. Ingestion via animal consumption in fragment form is likewise extremely improbable. Finally, dissolving of nickel fragments in a marine environment is a process slow enough to allow the water to reduce the concentration level below 3 x 10^{-5} microcuries per cm^3 as stated in Section 6.1.

6.3.2 Pulverized Switch Dispersion Without Wind

If it is assumed that all four switches aboard a vehicle are pulverized by an explosion in the launch pad silo, then the 160 microcuries of Ni^{63} will expand into a sphere. The concentration of Ni^{63} inside this sphere will decline as it expands. The Nuclear Regulatory Commission (NRC) concentration limits for air is 1.4 x 10^{-5} microcuries per m^3 (FR, 1989). The radius of the sphere that contains this concentration is given by the same equation as shown in Section 6.1:

$$r = \sqrt[3]{\frac{3\ m}{4\ \pi\ C}}$$

WHERE:

r = RADIUS OF SPHERE CONTAINING AIR COMPLIANCE CONCENTRATION
m = TOTAL MASS OF RADIOISOTOPE
C = LEVEL FOR AIR COMPLIANCE

USING THE APPROPRIATE DATA FOR AIR:

$$r = \left(\frac{(3)\quad 160 \text{ Microcuries}}{(4)\ (3.141)\ (1.4\ \text{x}10^{-5}\text{Microcuries/m}^3)} \right)^{1/3} = 140 \text{ Meters} = 460 \text{ Feet}$$

The Explosive Safety Quantity Distance (ESQD) for the GBI program is 1,250 feet and no personnel will be allowed within this concentration limit at the time of launch. Therefore, inhalation of Ni^{63} will be in concentrations below the established compliance criteria.

6.3.3 Pulverized Switch Dispersion with Wind

If the booster self-destructs within the launch pad area, the debris will fall within the 1,250 feet ESQD allowed by range safety. A possible scenario could be complete pulverization of the switches. The resulting expanding cloud of pulverized material would dilute the levels of radioactive substances to below allowable release limits. Recently published Environmental Protection Agency (EPA) Concentration Levels for Environmental Compliance indicate that when the spherical cloud enclosing the Ni^{63} reaches a radius of about 140 meters (460 feet), the concentration level for the Ni^{63} falls below the compliance level (FR, 1989) of 1.4 x 10^{-5} microcuries per m^3. This value occurs well within the 1,250 foot ESQD. Therefore, the chance that radioactive dust from the small cloud would be inhaled while above the concentration limit is small, due to the dilution that would take place within the ESQD. The presence of winds would further dilute this concentration.

The dispersal of the pulverized switches during flight destruction at any launch altitude can be calculated utilizing the techniques by Hay and Pasquill (1957). The formulation is based on

experimental evidence that the vertical distribution of spreading particles from an elevated point is related to the standard deviation of the wind elevation angle σ_e, at the point of release. Formulations based on this theory result in a diffusion equation, incorporating standard deviations of Gaussian distribution: σ_y for the distribution of material in the plume across wind in the horizontal, and σ_z for the vertical distribution of material in the plume. Further refinement by Pasquill (1961) results in a method for estimating diffusion when detailed wind data are not available. This method expresses the height and angular spread of a diffusion plume in terms of more commonly observed weather parameters. Curves of height and angular spread as a function of distance downwind are given for various stability classes. These stability classes are directly related to the wind speed at ground level.

Tradewinds from the northeast dominate the weather patterns at USAKA for most of the year, but are strongest from November to June (USASDC, 1989). Summer winds tend to be weaker with some slack periods. The prevailing winds at Kwajalein Atoll blow from the northeast or east with an average velocity of 16 mph during the winter months, decreasing to 9 mph by late summer. Strong winds tend to increase atmospheric dispersion of air pollutants. The prevailing conditions are fairly consistent, occurring 80% of the time. Wind data for Kwajalein have been collected and are available from three sources: (1) Summary of synoptic Meteorological Observations-Area 9, by the U.S. Naval Weather Service Command; (2) U.S. Air Force Weather Service; and (3) Local Climatological Data (USASDC, 1989). One calculation will assume a wind velocity of 2.2 mph that represents the most conservative case since as indicated above, atmospheric dispersion is increased with stronger winds. Another calculation assumed an 18 mph wind to represent a stronger wind condition.

The concentration, K, of particulates (a situation in which a switch is essentially vaporized) at the location x,y,z (Figure A-5) from a continuous source Q (microcuries/sec) at an altitude of H(meters) is given by the following equation:

$$K\ (x,y,z;H) = \frac{Q}{2\pi\sigma_y\sigma_z u}\exp\left[-\frac{1}{2}\left(\frac{(y)}{\sigma_y}\right)^2\right]$$

$$\left\{\exp\left[-\frac{1}{2}\left(\frac{z-H}{\sigma_z}\right)^2\right] + \exp\left[-\frac{1}{2}\left(\frac{z+H}{\sigma_z}\right)^2\right]\right\}$$

The parameters describing this calculation are the following:

Q = 160 (microcuries/sec) Concentration

x = 400 (meters) distance downwind

y = 0 (meters) distance cross wind

z = 0 (meters) distance vertical to ground

GEOMETRY FOR NI ^{63} OVERVOLTAGE GAP SWITCH DISPERSION

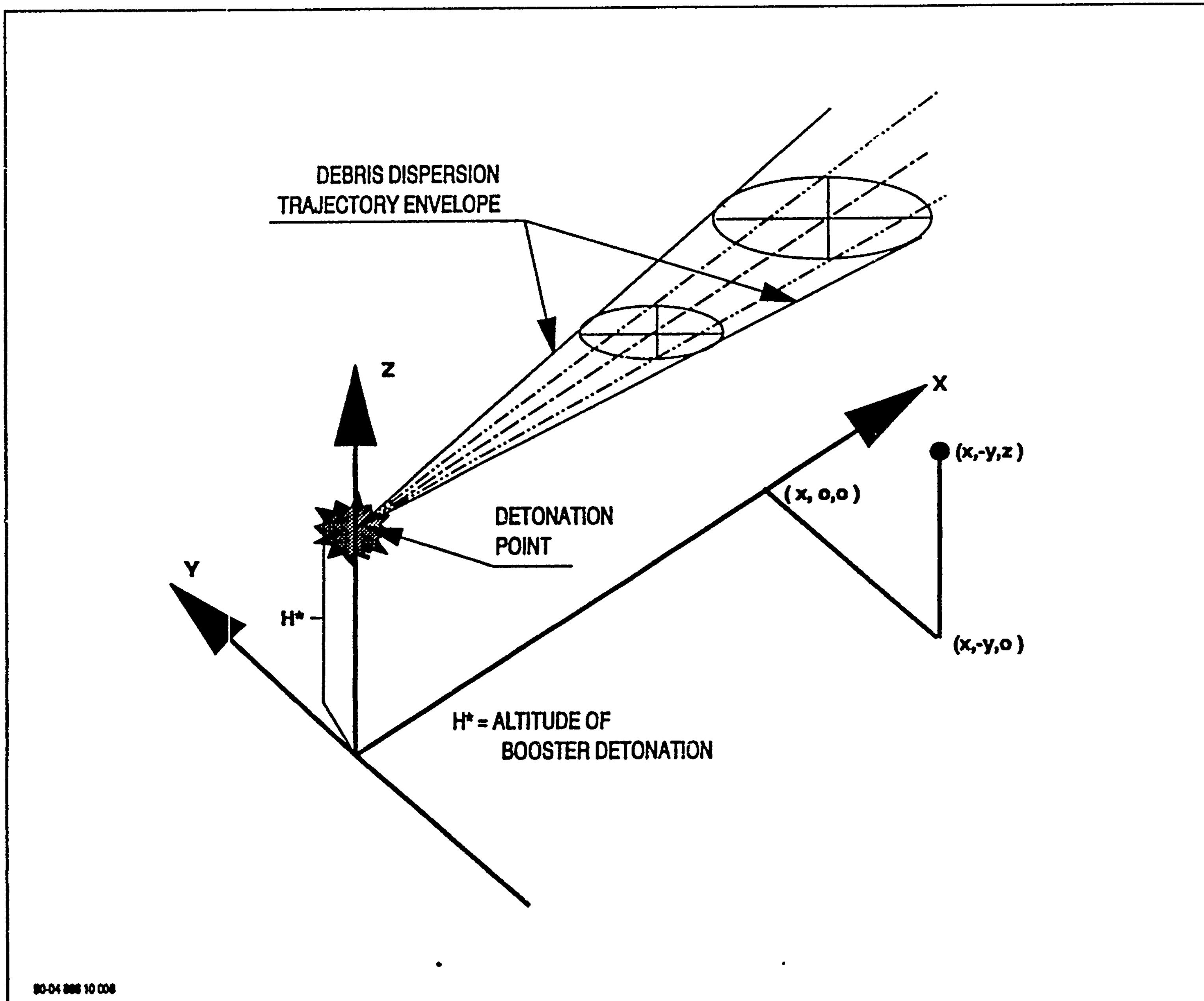


Figure A - 5

σ_y	=	300 (meters) horizontal dispersion coefficient (function of distance downwind)
σ_z	=	1,300 (meters) vertical dispersion coefficient
H	=	8,000 (meters) height above ground location of source
u	=	3.6 km/hr (2.2 mph) wind velocity and u = 30 km/hr (18 mph)
K	=	Concentration of particulates (microcuries per m^3)

The calculation for 3.6 km/hr (2.2 mph) wind resulted in a value of:

$$K = 7.81 \times 10^{-13} \text{ microcuries per } m^3$$

at 80 microcuries/sec, $K = 3.90 \times 10^{-13}$ microcuries per m^3.

The calculation for 30 km/hr (18 mph) wind and a 160 microcurie/sec source resulted in a value of effectively:

$$K = 9.37 \times 10^{-14} \text{ microcuries per } m^3$$

at 80 microcuries/sec, $K = 4.69 \times 10^{-14}$ microcuries per m^3.

These parameters are a conservative estimate since in this calculation, the source of 160 microcuries/sec, represents a continuous source, whereas the actual source would be a pulse of much shorter duration. The result is still well below the compliance level (Federal Register, 1989) of 1.4×10^{-5} microcuries per m^3.

7.0 GLOSSARY

C	Centigrade
CFR	Code of Federal Regulations
cm	centimeter (one-hundredth of a meter)
Curie	A special unit of radioactivity. One curie equals 3.7 x 10^{10} disintegrations per second.
DIU	Destruct Initiation Unit; used in Navy missiles
Environmental Assessment (EA)	A concise public document in which a Federal agency provides sufficient analysis and evidence for determining the need for an Environmental Impact Statement (EIS) or Finding of No Significant Impact (FNSI). EAs provide agencies with useful data regarding compliance with the NEPA and are an aid in the preparation of an EIS.
EPA	Environmental Protection Agency
ESQD	Explosive Safety Quantity Distance
FTS	Flight Termination System
g	A unit of force equal to the force exerted by gravity near the earth's surface to indicate the force to which a body is subjected when accelerated.
gm	gram
GBI	Ground-Based Interceptor
g^2/Hz	g^2/Hertz; unit used for power density
HV	High Voltage
HVA	High Voltage Assembly
Hz	Hertz is a unit of frequency equal to one cycle per second.
km	kilometer (one thousand meters)
km/hr	kilometer/hour
LMSC	Lockheed Missiles and Space Company, Incorporated

m	meter
MeV	Million Electron Volts
mg	milligram (one-thousandth of a gram)
Microcurie	One-millionth of a curie (3.7 x 10^4 disintegrations per second).
mm	millimeter (one-thousandth of a meter)
mph	miles per hour
Ni^{63}	Nickel radioisotope with a half life of 85 years and maximum 0.067 MeV of beta particle energy.
NRC	Nuclear Regulatory Commission
OSHA	Occupational Safety and Health Administration
psi	pounds per square inch, a unit of pressure
RAD	Unit of Absorbed Radiation Dose
REM	Acronym for roentgen equivalent in man. A unit for measuring a dose of radiation. A REM is equivalent to the amount of ionizing radiation required to produce the same biological effect in man as one roentgen of high-penetration x-rays.
SNL	Sandia National Laboratory
USAKA	U.S. Army Kwajalein Atoll

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APPENDIX B

CORRESPONDENCE

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION V
1450 MARIA LANE, SUITE 210
WALNUT CREEK, CALIFORNIA 94596-5368

FEB 6 1990

Lockheed Missiles and Space Company, Inc.
1111 Lockheed Way
Orgn: 47-20, Building No. 106
Sunnyvale, California 94089

Attention: Mr. J. Freeman
Executive Vice President; Finance/Administration

Gentlemen:

NRC no longer has jurisdiction in the Marshall Islands, due to their new independent status.

If we did have jurisdiction, we would issue a license to Lockheed Missiles and Space Company, Inc. based on their letter which was sent to us by facsimile on February 6, 1990. The license would be similar to terminated License 04-01964-11.

If there are questions concerning these matters, I can be contacted at (415) 943-3765.

Sincerely,

Beth A. Riedlinger

Beth A. Riedlinger
Senior Health Physicist
(Licensing)

DEPARTMENT OF THE ARMY

HEADQUARTERS, U.S. ARMY KWAJALEIN ATOLL
BOX 26, APO SAN FRANCISCO 96555

CSSD-KA-RS (385-11e)

13 FEB 1989

MEMORANDUM FOR CSSD-GI

SUBJECT: ERIS DA Radiation Permit - USAKA Approval

1. USAKA has received DA Approval, Enclosure 1, of the Lockheed requested radiation permit. Strict adherence to the stated permit requirements and controls by Lockheed is essential to ensure adequate operational safety. Although this provides the necessary safety approvals for the entire operation at USAKA, other complications presently necessitate conditional operational approval by USAKA.

2. Limited USAKA approval is hereby given to Lockheed to bring, store, checkout, and test the permitted material at USAKA. Final approval to fly the ERIS missile from USAKA is withheld pending final resolution of environmental concerns and actions by your office.

Philip R. Harris

PHILIP R. HARRIS
Colonel, EN
Commanding

Encl

CF:
CSSD-GI-T
CSSD-GI-U
CSSD-SO

CSSD-SO (385-10d) 14 Feb 90

MEMORANDUM FOR COMMANDER, U.S. ARMY KWAJALEIN ATOLL, P.O. BOX 26, APO SAN FRANCISCO 96555

SUBJECT: Department of Army Radioactive Permit Number P52-01-04-Lockheed Missiles and Space Co., Inc.

1. Enclosed is the original of subject permit.

2. Point of contact is Mr. Joseph Klevorn, AUTOVON 788-4801.

Encl

PHILIP R. OWEN
Chief, Safety Office

CF:
CSSD-KA-RS (2)
√CSSD-GI

DEPARTMENT OF THE ARMY
HEADQUARTERS, U. S. ARMY MATERIEL COMMAND
5001 EISENHOWER AVENUE, ALEXANDRIA, VA 22333-0001

AMCSF-P

2 February 1990

MEMORANDUM FOR Commander, U.S. Army Strategic Defense Command, P. O. Box 1500, ATTN: CSSD-SO, Huntsville, AL 35807

SUBJECT: Department of the Army Radioactive Permit Number P52-03-04 - Lockheed Missiles and Space Co., Inc.

1. Forwarded is subject permit. The permit authorizes use of Nickel-63 in electronic gap switches contained in the Exoatmospheric Reentry Body Interceptor System at Kwajalein Missile Range. Please forward the original permit to Lockheed Missiles and Space Co., Inc.

2. Point of contact is Ms. Patricia Elker, AUTOVON 284-5476.

FOR THE COMMANDER:

Encl (2 cys)

DARWIN N. TARAS
Chief
Safety Office

CF (w/encl):
HQDA (SGPS-PSP-E)
Director, USAMC Field Safety Activity, ATTN: AMXOS-PE

DEPARTMENT OF THE ARMY
AUTHORITY FOR
POSSESSION AND USE OF RADIOACTIVE MATERIALS

In reliance on statement and representation made by the applicant, authority is hereby granted to receive, produce, transfer, possess, use and store the material(s) designated in Item 5. This authority is subject to conditions specified below.

Activity Granted Authority	3. Authorization/Permit No.
1. Name: Lockheed Missiles & Space Co., Inc.	P 52-01-04
2. Address: Kwajalein Missile Range Kwajalein, Marshall Islands	4. Expiration Date: 31 January 1993

5. Material & Mass Number	6. Chemical and/or Physical Form	7. Quantity Limitation
a. Nickel-63	a. Metallic nickel electroplated	a. 40 microcuries per electronic gap switch; 4 per circuit board

8. Authorized Use:

a. Used in the Exoatmospheric Reentry Body Interceptor System

Conditions

9. Unless otherwise specified, the authorized place of use is as stated in item 2 above.
10. Upon completion of project, Lockheed Missiles and Space Co., Inc. shall be responsible for decontamination and restoration of premises to original condition for unrestricted use based on NRC criteria.
11. Local disposal of radioactive waste is not permitted.
12. Disposal of radioactive sources will be IAW Federal and local regulations.
13. Unless specifically provided otherwise, the materials listed in items 5, 6, and 7 shall be possessed and used IAW statements, representations, and procedures made in application DA Form 3337, dtd 1 Jan 90, signed by J. C. Suty, V. P. Operations; Title 10, Code of Federal Regulations; and AR 385-11.

APPROVED

DARWIN N. TARAS
Chief
Safety Office

AUTHORIZED SIGNATURE

DATE: 2 February 1990

AMC Form 2180-R, 1 Mar 85

License Number 0169-43

Amendment Number 52

RADIOACTIVE MATERIAL LICENSE

Supplementary Sheet

SAFETY RECORDS ADMIN

JAN 08 1990

AM 7,8,9,10,11,12,1,2,3,4,5,6 PM

Lockheed Missiles and Space Company, Inc.
Radiation Control Program
1111 Lockheed Way, 0/47-20, B/106
Sunnyvale, CA 94089

Attention: George M. Tomer, Chairman
Radiation Control Committee

License Number 0169-43 is hereby amended in part as follows:

To add:

13. (k) The letter with attachments dated December 5, 1989, signed by J. Freeman, Executive Vice President.

To read:

14. (a) The radiation safety officer in this program shall be Donald P. Mercado.

(b) The chairperson of the radiation safety committee shall be George M. Tomer.

(c) The alternate radiation safety officer shall be Steve Souza.

For the State Department of Health Services

Date December 27, 1989

by [signature]

Radiologic Health Branch

License Number 0169-43

Amendment Number 51

RADIOACTIVE MATERIAL LICENSE

Supplementary Sheet

Lockheed Missiles and Space Co., Inc.
Radiation Control Program
1111 Lockheed Way, 0/47-20, B/106
Sunnyvale, CA 94089

Attention: A. C. Hammons, Chairman
Radiation Control Committee

In response to the letter dated July 25, 1988 signed by Donald P. Mercado, License Number 0169-43 is hereby amended in part as follows:

2. Address: 1111 Lockheed Way, 0/47-20, B/106
Sunnyvale, CA 94089

RADIATION CONTROL
AUG 1 5 1988
AM 7,8,9,10,11,12,1,2,3,4,5,6 PM
4

Date August 10, 1988

For the State Department of Health Services

by

Radiologic Health Branch
714 P Street, Sacramento, CA 95814

RH 2551 (2/82)

State of California—Health and Welfare Agency

OCCUPATIONAL SAFETY & HEALTH

JUN 1 2 1987

AM 7 8 9 10 11 12 1 2 3 4 5 6 PM

Department of Health Services

RADIOACTIVE MATERIAL LICENSE

Pursuant to the California Administrative Code, Title 17, Chapter 5, Subchapter 4, Group 2, Licensing of Radioactive Material, and in reliance on statements and representations heretofore made by the licensee, a license is hereby issued authorizing the licensee to receive, use, possess, transfer, or dispose of radioactive material listed below; and to use such radioactive material for the purpose(s) and at the place(s) designated below. This license is subject to all applicable rules, regulations, and orders of the Department of Health Services now or hereafter in effect and to any conditions specified in this license.

1. *Licensee* Lockheed Missiles and Space Co., Inc. Radiation Control Program	3. *License No.* 0169-43 is hereby amended in its entirety. *Amendment No.* 50
2. *Address* 0/47-20, B/102 1111 Lockheed Way Sunnyvale, CA 94089	4. *Expiration date* December 19, 1993
Attention: A. C. Hammons, Chairman Radiation Control Committee	5. *Inspection agency* Division of Occupational Safety and Health-N

6. Nuclide	7. Form	8. Possession Limit
A. ^{3}H	A. Any	A. 600 Ci
B. Any with atomic numbers 3-83	B. Any	B. 100 Ci
C. Any with atomic numbers 3-83	C. Sealed sources	C. 500 Ci
D. Any with atomic numbers 84-105 except source and SNM	D. Any	D. 10 Ci
E. Any with atomic numbers 84-105 except source and SNM	E. Sealed sources	E. 30 Ci
F. Source material	F. Any	F. 11,000 lbs
G. Special nuclear material (SNM)	G. Any	G. 100 Gm
H. Special nuclear material (SNM)	H. Sealed sources	H. 100 Gm
I. Radium 226	I. Foil (NRC Equipment Corporation)	I. 25 millicuries total in sources not over 500 uCi each
J. Ytterbium 169	J. Sealed sources (LMSC Model 65101)	J. 6 sources not to exceed 2.5 Curies per source

For the State Department of Health Services

Date May 20, 1987 by

Radiologic Health Section
744 P Street, Sacramento, CA 95814

RH 2550 (2/81)

RADIOACTIVE MATERIAL LICENSE

Supplementary Sheet

License Number 0169-43

Amendment Number 50

6. Nuclide (continued)	7. Form (continued)	8. Possession Limit (continued)
K. Krypton 85	K. Gas	K. 100 Curies
L. Krypton 85	L. Sealed sources, custom (General Nucleonics)	L. 20 sources, not to exceed 600 millicuries per source
M. [illegible]	M. Sealed source, custom (Isotope Products Lab)	M. 5 sources, not to exceed 50 millicuries per source
N. Californium 252	N. Sealed sources (USERDA Model SR-CF-100)	N. 2 sources, not to exceed 5.2 Ci per source; total all sources not to exceed 8 Curies
O. Curium 244	O. Sealed sources (Isotope Products Lab., Model AF-244-C)	N. 20 sources, not to exceed 2 millicuries per source
P. Nickel 63	P. Sealed source, custom (NEN - used in EG&G Electron tubes, type 328986)	P. 2,500 electron tubes (switches) not to exceed 40 uCi per tube, total all tubes not to exceed 100 millicuries
Q. Carbon 14	Q. Sealed source, custom (NEN - used in EG&G Electron tubes, type 343314)	Q. 1,050 electron tubes not to exceed 85 microcuries per tube, total not to exceed 90 millicuries
R. Any with atomic numbers 3-83	R. Irradiated electronic components, sealed sources, foils, and electro-deposits on various substrates.	R. 100 millicuries total in sources not to exceed 30 millicuries per source
S. Any with atomic numbers 84-105 except source and special nuclear material	S. Sealed sources, any approved make and model	S. 10 millicuries total in sources not to exceed [illegible] millicuries per source
T. Source material	T. Any	T. 20 pounds total
U. Special nuclear material	U. Sealed sources, any approved make and model	U. Total not to exceed 1 gram

For the State Department of Health Services

Date May 20, 1987

by

Radiologic Health Branch
714 P Street, Sacramento, CA 95814

RADIOACTIVE MATERIAL LICENSE

Supplementary Sheet

License Number 0169-43

Amendment Number 50

6. Nuclide (continued)	7. Form (continued)	8. Possession Limit (continued)
V. Cobalt 60	V. Sealed sources (AECL Model C198)	V. Source array, total not to exceed 2,700 Curies

9. Authorized Use

A.-E. To be used for research and development as defined by Section 30175 (J) of California Radiation Control Regulations, Calibration of Instruments and Irradiation of Missile and Satellite Components.

F. To be used for research and development as defined by Section 30175 (J) of California Radiation Control Regulations, and for fabrication of components, including machining, forming, welding, and quality control testing.

G. To be used for research and development as defined by Section 30175 (J) of California Radiation Control Regulations, and for use as fission foils and components of fission detector instruments.

H. To be used for calibration of instruments.

I. To be used as components of NRC equipment Alphatron gauges.

J. To be used in Lockheed Missiles and Space Company's Radiographic Exposure Device Model 5032239 for Industrial Radiography.

K. To be used in an ISO Vac Engineering Corporation leak test system Model V for leak testing of components.

L. To be used as components of gauging systems on satellites, including installation of sources and servicing of gauging systems.

M. To be used for calibration of instruments.

N. To be used in an IRT Corporation custom projector for neutron radiography.

O. To be used for calibration of experimental proportional counters.

P.-Q. To be used for assembly of tubes into printed circuit boards, coated with RTV/Silicon sealed into a metal enclosure and encased in a final use container.

For the State Department of Health Services

Date May 20, 1987

by

Radiologic Health Branch
714 P Street, Sacramento, CA 95814

RADIOACTIVE MATERIAL LICENSE

Supplementary Sheet

License Number 0169-43

Amendment Number 50

9. Authorized Use (continued)

R.-U. Calibration of instruments that are flown on missiles or spacecraft; irradiation testing of electronic hardware; electronic testing of irradiated hardware.

V. To be used in an AECL Irradiator, Model Gammacell 220, for irradiation studies of materials as specified in Condition 13 of this license, as applicable.

---

10. (a) Radioactive material described in this license may be used, as specified in Condition 13, at the following locations:

(1) 1111 Lockheed Way, Sunnyvale, California.
(2) 3251 Hanover Street, Palo Alto, California.
(3) 3170 Porter Drive, Palo Alto, California.
(4) 32 Draggett Drive, San Jose, California.
(5) 227 Curtis Avenue, Milpitas, California..
(6) 45 Plumeria Drive, San Jose, California.
(7) 930 Remillard Court, San Jose, California.
(8) 940 Remillard Court, San Jose, California.
(9) Santa Cruz Facility, Rural Station Road, Santa Cruz, California.
(10) 3380 North Harbor Drive, San Diego, California.

(b) Radioactive material described in Subitems J, R, S, T, and V may also be used at temporary job sites of the licensee in areas not under exclusive federal jurisdiction throughout the State of California.

11. This license is subject to an annual fee for sources of radioactive material authorized to be possessed at any one time as specified in Item 8 of this license. The annual fee for this license is required by and computed in accordance with Sections 30230-30232 of the California Radiation Control Regulations and is also subject to an annual cost-of-living adjustment pursuant to Section 113 of the California Health and Safety Code.

12. Radioactive material described in this license may be used as follows:

(a) For all Subitems (except Subitem S), radioactive material may be used by, or under the supervision of, any qualified person as designated in writing by the Radiation Control Committee.

For the State Department of Health Services

Date May 20, 1987

by

Radiologic Health Branch
714 P Street, Sacramento, CA 95814

RADIOACTIVE MATERIAL LICENSE

Supplementary Sheet

License Number 0169-43

Amendment Number 50

(b) Radioactive material described in Subitem K of this license may be used by individuals as follows:

(1) Maintenance and repair of ISO Vac Engineering Model V leak testing units shall be performed only by individuals specifically authorized to perform that service.

(2) Transfer of Krypton 85 to or from ISO Vac Engineering Model V leak testing units, and use of Krypton 85 in ISO Vac Engineering Model V leak testing units in any mode other than automatic mode, shall be performed only by, or under the supervision and in the physical presence of, individuals who:

(i) Have received a certificate of satisfactory completion of a course in all operations of leak testing units containing Krypton 85, such course conducted by a person licensed to use Krypton 85 for that purpose and

(ii) Have been designated, in writing, by the radiation safety officer as qualified to use Krypton 85 in these manners.

(3) Use of Krypton 85 in ISO Vac Engineering Model V leak testing units in automatic mode and for testing components removed from such units for amount of radioactivity, shall be performed only by or under the supervision and in the physical presence of individuals who have been designated, in writing, by the radiation safety officer as qualified to use Krypton 85 in [illegible]

14. Except as specifically provided otherwise by this license, the licensee shall possess and use radioactive material described in Items 6, 7, and 8 of this license in accordance with statements, representations, and procedures contained in the documents listed below. The Department's regulations shall govern unless the statements, representations, and procedures in the licensee's application and correspondence are more restrictive than the regulations.

✓(a) The application (with attachments) dated October [illegible], 1984 signed by C. R. [illegible]

(b) The letter (with attachments) dated September [illegible], [illegible] signed by Henry [illegible]

✓(c) The letters (with attachments) dated May 1, 1986 and June 11, 1986 signed by C. R. Scanlon and A. C. Hammons respectively.

(d) The letter (with attachments) dated September 25, 1986 signed by A. C. Hammons.

✓(e) The letter dated October 4, 1984 signed by C. R. Scanlon.

For the State Department of Health Services

Date May 20, 1987

by

Radiologic Health Branch
714 P Street, Sacramento, CA 95814

RADIOACTIVE MATERIAL LICENSE

Supplementary Sheet

✓ (f) The letter (with attachments) dated November 17, 1986 signed by A. C. Hammons.

✓ (g) The letter dated November 26, 1986 signed by A. C. Hammons.

✓ (h) The letter (with attachment) dated December 9, 1986 signed by A. C. Hammons.

✓ (i) The letter (with attachments) dated January 16, 1987 signed by A. C. Hammons.

✓ (j) The letter (with attachments) dated April 20, 1987 signed by A. C. Hammons.

14. (a) The radiation safety officer in this program shall be A. C. Hammons.

(b) The chairperson of the Radiation Control Committee shall be A. C. Hammons.

(c) The alternate radiation safety officer shall be Don P. Mercado.

(d) The radiation safety officer for the facility located at 3380 North Harbor Drive, San Diego, shall be Frank Simpson.

(e) The assistant radiation safety officer shall be Terry L. Vaughn.

15. Notwithstanding the authorizations granted in Condition 9 of this license, the licensee is permitted to fabricate sealed sources only for its own use, provided that:

(a) Each sealed source so fabricated does not contain more than 5 millicuries.

(b) The fabrication process is conducted only at the 3251 Hanover Street, Palo Alto, location.

(c) Each sealed source fabricated by the licensee shall be inspected and tested for construction defects, leakage, and contamination prior to use or transfer as a sealed source. If the inspection or test reveals any construction defects or 0.005 microcuries or greater of contamination, the source shall not be used or transferred as a sealed source until it has been repaired, decontaminated, and retested.

16. Gas chromatograph units containing titanium tritide foil shall not be operated at temperatures exceeding 225 degrees centigrade.

For the State Department of Health Services

Date May 20, 1987

by

RADIOACTIVE MATERIAL LICENSE

Supplementary Sheet

License Number 0169-43

Amendment Number 50

17. The licensee is authorized to discharge Krypton 85 to the environment as required by normal operation of the ISO Vac Engineering Model Mark V leak testing unit provided that:

    (a) Not more than 200 Curies of Krypton 85 shall be discharged to the environment in any period of 365 days.

    (b) Not more than 5 Curies of Krypton 85 shall be discharged to the environment in any 24-hour period.

18. The licensee shall within 24 hours notify the California State Department of Health Services, 714 P Street, Sacramento, CA 95814, of any discharge to the environment of more than 5 Curies of Krypton 85 in any period of 24 hours.

19. The licensee is hereby granted an exemption to Section 30275 (c) of California Radiation Control Regulations to the extent that radioactive foils described in Subitem I of this License may be tested for leakage or contamination at intervals not to exceed 3 years.

20. The licensee is hereby granted an exemption from the requirements of Section 30275 (c) of California Radiation Control Regulations for leak testing of sealed sources of not more than 300 microcuries of Thallium 204 provided the licensee performs leak tests as described in the attachments to the applications listed in Condition 13 of this license.

21. All uses of radioactive material under this license shall be conducted in accordance with the user's application to and modifying requirements of the Radiation Control Committee. The review of intramural applications shall include findings with respect to matters specified in Title 17, California Administrative Code, Section 30194. Documentation of these findings shall be maintained for review by the Department or its authorized representative.

22. The licensee is hereby granted an exemption from the requirements of Section 302[illegible] (b) (3), California Radiation Control Regulations, to the extent that the licensee is authorized to post the modified Form RH 2364, as depicted in the application attachment of Condition 13 [illegible] of this license, in lieu of the full [illegible] Form RH 2364.

[illegible]. [illegible] licensee is hereby granted an exemption from the requirements of Section 3027[illegible] (c) of California Radiation Control Regulations for leak testing of sealed sources described in Subitem P of this license.

24. Pursuant to California Radiation Control Regulations, the licensee is authorized to possess up to 999 kilograms (2,203 pounds) of natural or depleted uranium used for purposes of shielding or collimation in radiographic exposure devices listed in Item 9 of this license.

For the State Department of Health Services

Date May 20, 1987

by

Radiologic Health Branch
714 P Street, Sacramento, CA 95814

RADIOACTIVE MATERIAL LICENSE

Supplementary Sheet

25. Detector cells containing Nickel 63 shall be tested for leakage and/or contamination at intervals not to exceed six months.

26. Sealed sources possessed under this license shall be tested for leakage and/or contamination as required by Section 30275 (c) of the California Radiation Control Regulations.

27. Records of leak test results shall be kept in units of microcuries and maintained for inspection. Records may be disposed of following Department inspection. Any leak test revealing the presence of 0.005 microcuries or more of removable radioactive material shall be reported to the Department of Health Services, Radiologic Health Branch, 744 P Street, Sacramento, CA 95814, within five days of the test. This report shall include a description of the defective source or device, the results of the test, and the corrective action taken.

28. The following individuals are authorized to collect wipe test samples of sealed sources possessed under this license using leak test kits acceptable to the California Department of Health Services.

(a) The radiation safety officer.

(b) Any qualified person as designated in writing by the radiation safety officer.

For the State Department of Health Services

Date May 20, 1987

by [signature]

Radiologic Health Branch

714 P Street, Sacramento, CA 95814

RH 2251 (2/82)

NRC FORM 313
7-86
10 CFR 30, 32, 33, 34
35 and 40

U.S. NUCLEAR REGUL...

APPLICATION FOR MATERIAL LICENSE

INSTRUCTIONS. SEE THE APPROPRIATE LICENSE APPLICATION GUIDE FOR DETAILED INSTRUCTIONS FOR COMPLETING APPLICATION. SEND TWO C... OF THE ENTIRE COMPLETED APPLICATION TO THE NRC OFFICE SPECIFIED BELOW

APPLICATIONS FOR DISTRIBUTION OF EXEMPT PRODUCTS FILE APPLICATIONS WITH

U.S. NUCLEAR REGULATORY COMMISSION
DIVISION OF FUEL CYCLE AND MATERIAL SAFETY, NMSS
WASHINGTON, DC 20555

ALL OTHER PERSONS FILE APPLICATIONS AS FOLLOWS. IF YOU ARE LOCATED IN:

CONNECTICUT, DELAWARE, DISTRICT OF COLUMBIA, MAINE, MARYLAND, MASSACHUSETTS, NEW HAMPSHIRE, NEW JERSEY, NEW YORK, PENNSYLVANIA, RHODE ISLAND, OR VERMONT, SEND APPLICATIONS TO

U.S. NUCLEAR REGULATORY COMMISSION, REGION I
NUCLEAR MATERIALS SAFETY SECTION B
631 PARK AVENUE
KING OF PRUSSIA, PA 19406

ALABAMA, FLORIDA, GEORGIA, KENTUCKY, MISSISSIPPI, NORTH CAROLINA, PUERTO RICO, SOUTH CAROLINA, TENNESSEE, VIRGINIA, VIRGIN ISLANDS, OR WEST VIRGINIA, SEND APPLICATIONS TO

U.S. NUCLEAR REGULATORY COMMISSION, REGION II
NUCLEAR MATERIALS SAFETY SECTION
101 MARIETTA STREET, SUITE 2900
ATLANTA, GA 30323

IF YOU ARE LOCATED IN

ILLINOIS, INDIANA, IOWA, MICHIGAN, MINNESOTA, MISSOURI, OHIO, OR WISCONSIN, SEND APPLICATIONS TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION III
MATERIALS LICENSING SECTION
799 ROOSEVELT ROAD
GLEN ELLYN, IL 60137

ARKANSAS, COLORADO, IDAHO, KANSAS, LOUISIANA, MONTANA, NEBRASKA, NEW MEXICO, NORTH DAKOTA, OKLAHOMA, SOUTH DAKOTA, TEXAS, UTAH OR WYOMING, SEND APPLICATIONS TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION IV
MATERIAL RADIATION PROTECTION SECTION
611 RYAN PLAZA DRIVE, SUITE 1000
ARLINGTON, TX 76011

ALASKA, ARIZONA, CALIFORNIA, HAWAII, NEVADA, OREGON, WASHINGTON AND U.S. TERRITORIES AND POSSESSIONS IN THE PACIFIC, SEND APPLICATIONS TO

U.S. NUCLEAR REGULATORY COMMISSION, REGION V
NUCLEAR MATERIALS SAFETY SECTION
1450 MARIA LANE, SUITE 210
WALNUT CREEK, CA 94596

PERSONS LOCATED IN AGREEMENT STATES SEND APPLICATIONS TO THE U.S. NUCLEAR REGULATORY COMMISSION ONLY IF THEY WISH TO POSSESS AND USE LICENSED MAT... IN STATES SUBJECT TO U.S. NUCLEAR REGULATORY COMMISSION JURISDICTION.

1. THIS IS AN APPLICATION FOR *(Check appropriate item)*

[X] A. NEW LICENSE Please refer to License 04-01964-
[ ] B. AMENDMENT TO LICENSE NUMBER ____________
[ ] C. RENEWAL OF LICENSE NUMBER ____________

2. NAME AND MAILING ADDRESS OF APPLICANT *(Include Zip Code)*

Lockheed Missiles & Space Co., Inc.
Orgn. 47-20, Bldg. 106
1111 Lockheed Way
Sunnyvale, CA 94089

3. ADDRESS(ES) WHERE LICENSED MATERIAL WILL BE USED OR POSSESSED

Lockheed facilities located at Kwajalein Missile Range, Kwajalein, Marshall Islands, ar... at temporary job sites anywhere in the United States where the U.S. Nuclear Regulatory Commission maintains jurisdiction for regulation of the use of licensed material.

4. NAME OF PERSON TO BE CONTACTED ABOUT THIS APPLICATION

Don P. Mercado, Radiation Control Officer

TELEPHONE NUMBER (408)742-0759

SUBMIT ITEMS 5 THROUGH 11 ON 8½ x 11" PAPER. THE TYPE AND SCOPE OF INFORMATION TO BE PROVIDED IS DESCRIBED IN THE LICENSE APPLICATION GUIDE.

5. RADIOACTIVE MATERIAL
a. Element and mass number; b. chemical and/or physical form; and c. maximum amount which will be possessed at any one time.
See attachment

6. PURPOSE(S) FOR WHICH LICENSED MATERIAL WILL BE USED
see attachment

7. INDIVIDUAL(S) RESPONSIBLE FOR RADIATION SAFETY PROGRAM AND THEIR TRAINING AND EXPERIENCE
see attachment

8. TRAINING FOR INDIVIDUALS WORKING IN OR FREQUENTING RESTRICTED AR...
see attachment

9. FACILITIES AND EQUIPMENT
see attachment

10. RADIATION SAFETY PROGRAM
see attachment

11. WASTE MANAGEMENT
see attachment

12. LICENSEE FEES *(See 10 CFR 170 and Section 170.31)*
FEE CATEGORY 3D
AMOUNT ENCLOSED $ 220.00

13. CERTIFICATION *(Must be completed by applicant)* THE APPLICANT UNDERSTANDS THAT ALL STATEMENTS AND REPRESENTATIONS MADE IN THIS APPLICATION ARE BINDING UPON THE APPLICANT.

THE APPLICANT AND ANY OFFICIAL EXECUTING THIS CERTIFICATION ON BEHALF OF THE APPLICANT, NAMED IN ITEM 2, CERTIFY THAT THIS APPLICATION IS PREPARED IN CONFORMITY WITH TITLE 10, CODE OF FEDERAL REGULATIONS, PARTS 30, 32, 33, 34, 35, AND 40 AND THAT ALL INFORMATION CONTAINED HEREIN IS TRUE AND CORRECT TO THE BEST OF THEIR KNOWLEDGE AND BELIEF.

WARNING: 18 U.S.C. SECTION 1001 ACT OF JUNE 25, 1948, 62 STAT. 749 MAKES IT A CRIMINAL OFFENSE TO MAKE A WILLFULLY FALSE STATEMENT OR REPRESENTATION TO ANY DEPARTMENT OR AGENCY OF THE UNITED STATES AS TO ANY MATTER WITHIN ITS JURISDICTION.

SIGNATURE—CERTIFYING OFFICER	TYPED/PRINTED NAME	TITLE	DATE
[signature]	Freeman	Executive Vice President Finance/Administration	12-8-89

14. VOLUNTARY ECONOMIC DATA

a. ANNUAL RECEIPTS
[ ] <$250K [ ] $1M–3.5M
[ ] $250K–500K [ ] $3.5M–7M
[ ] $500K–750K [ ] $7M–10M
[ ] $750K–1M [ ] >$10M

b. NUMBER OF EMPLOYEES *(Total for entire facility excluding outside contractors)*

c. NUMBER OF BEDS

d. WOULD YOU BE WILLING TO FURNISH COST INFORMATION *(Dollar and/or staff hours)* ON THE ECONOMIC IMPACT OF CURRENT NRC REGULATIONS OR ANY FUTURE PROPOSED NRC REGULATIONS THAT MAY AFFECT YOU? *(NRC regulations permit it to protect confidential commercial or financial—proprietary—information furnished to the agency in confidence)*
[ ] YES [ ] NO

FOR NRC USE ONLY

TYPE OF FEE	FEE LOG	FEE CATEGORY	COMMENTS	APPROVED BY
AMOUNT RECEIVED	CHECK NUMBER			DATE

5. RADIOACTIVE MATERIAL

A. Element & Mass No.	B. Chemical and/or Physical Form	C. Maximum Amount Which will be possessed at any one time
Nickel ^{63}	Metallic electro-plated sources contained in electron tubes (EG&G)	Not to exceed 40 microcuries per tube

6. PURPOSE(S) FOR WHICH LICENSED MATERIAL WILL BE USED

Four (4) each Destruct Initiation Units in which the overvoltage gaps are installed will be assembled into an Exoatmospheric Reentry Body Interceptor System. These missiles will be launched from Meck Island, Kwajalein Missile Range. The Destruct Initiation Unit circuitry is designed to destroy the (ERIS) missile system should it stray off course or not function according to preprogramed design criteria.

The Destruct Initiation Units will remain intact during the launch provided the missile performs as desigred. The Destruct Initiation Units will remain with the booster section when it has fulfilled its function and is separated and ejected from the missile system. The booster section of the missile with the minuscule 160 microcuries of Nickel^{63} radioactive material will be destroyed or dispersed to the atmosphere or be scattered in the broad ocean area of the Kwajalein Missile Range.

7. INDIVIDUAL(S) RESPONSIBLE FOR THE RADIATION SAFETY PROGRAM AND THEIR TRAINING AND EXPERIENCE:

The radioactive materials will be used under the direction of Don P. Mercado, LMSC Radiation Control Officer, or Jeff Beckmann, Orgn. 59-6H at the Kwajalein Missile Range, Marshall Islands.

Attached is a resume for D.P. Mercado, LMSC Radiation Control Officer and Course Enrollment/Completion cards for Jeffery L. Beckmann which stipulate that Mr. Beckmann successfully completed LMSC's course number 0X001C entitled, "Radiation Safety" and course number 0X006E, entitled "Over-voltage Gap Switches."

8. TRAINING FOR INDIVIDUALS WORKING IN OR FREQUENTING RESTRICTED AREAS

All individuals working in or frequenting the area in which these devices are used or stored shall receive instructions that are commensurate with the degree of hazard in accordance with the Code of Federal Regulations, Title 10, Part 19.

A slide/tape training program course number 0X006E, entitled "Overvoltage Gap Switches," has been developed specifically for this particular program. All employees frequenting any area in which these devices are used or stored shall receive this training.

9. FACILITIES AND EQUIPMENT

The Destruct Initiation Units containing the overvoltage gap switches shall be stored in locked cabinets and secured against unauthorized removal.

10. RADIATION SAFETY PROGRAM

RADIATION SAFETY PROGRAM
FOR OVERVOLTAGE GAP SWITCHES USED IN
EXOATMOSPHERIC REENTRY BODY
INTERCEPTOR SYSTEM

10.1 BACKGROUND

An overvoltage gap switch (PN 3084386) is used in packages integral to the Exoatmospheric Reentry Body Interceptor Missile System. These gap switches contain 40 microcuries of Nickel^{63} a radioactive isotope of nickel. The amount of radioactive material in these components places them under the requirements of the Code of Federal regulations pertaining to control of radiation sources.

10.2 PURPOSE AND SCOPE

The purpose of this program is to define the requirements for use of the materials at Kwajalein Missile Range.

10.3 RECORDS

Lockheed Missiles & Space Company, Inc., shall establish a system for recording all receipts and transfer of these controlled units. Records shall include, by serial number, date received, each transfer of custody, and installation by missile serial number.

10.4 INSTRUCTION OF AFFECTED PERSONNEL

All personnel involved in handling controlled packages shall be given instructions pursuant to the requirements of the Code of Federal Regulations Title 10, Part 19.0. Appropriate documents shall be posted in the vicinity of the work area or made available to affected personnel.

10.5 STORAGE AND WORK AREA CONTROL

When not in use, controlled packages shall be secured to prevent unauthorized access or removal. All receipts, processing, and transfer of controlled packages must be controlled by personnel who have satisfied requirements of paragraph 4.0. All work areas containing three or more Destruct Initiation Units must be posted with "CAUTION RADIOACTIVE MATERIAL" signs.

10.6 AUDITS

Compliance with the Radiation Program shall be assessed by frequent and random audits of the affected areas and associated functions.

FORMAL TRAINING IN RADIATION SAFETY N/A

EXPERIENCE N/A

11. WASTE MANAGEMENT

Four (4) each Destruct Initiation Units in which the overvoltage gaps are installed will be assembled into an Exoatmospheric Reentry Body Interceptor System. These missiles will be launched from Meck Island, Kwajalein Missile Range. The Destruct Initiation Unit circuitry is designed to destroy the (ERIS) missile system should it stray off course or not function according to preprogramed design criteria.

The Destruct Initiation Units will remain intact during the launch provided the missile performs as designed. The Destruct Initiation Units will remain with the booster section when it has fulfilled its function and is separated and ejected from the missile system. The booster section of the missile with the minuscule 160 microcuries of Nickel^{63} radioactive material will be destroyed or dispersed to the atmosphere or be scattered in the broad ocean area of the Kwajalein Missile Range.

All Destruct Initiation Units not used in the test at the Kwajalein Missile Range shall be returned to:

Lockheed Missiles & Space Company, Inc.
Orgn. 47-20, Bldg. 106
1111 Lockheed Way
Sunnyvale, CA 94089
Attention: D. P. Mercado
Radiation Control Officer

EMERGENCY PROCEDURES

FOR AN

UNPLANNED INCIDENT INVOLVING THE

GAP SWITCH, PN 3084386

1. The only way that radioactive material can escape is if the gap switch is physically damaged in some way, such as crushing it, striking it, or applying some sort of mechanical force or pressure, or if a leak develops in the encapsulator material, or the material is engulfed in a fire or damaged by explosive force.

2. All personnel are to evacuate the room or area immediately, whenever it is suspected that the integrity of the gap switch is compromised by any of the above. The Radiation Control Officer is to be notified immediately.

   DO NOT RE-ENTER the room or area until specific approval is given by the Radiation Control Officer.

3. The Radiation Control Officer shall make a radiation survey of all possible areas that may be affected by the release of these materials and control access to those areas.

   RADIATION CONTROL OFFICER

	Phone Sunnyvale	Phone Home	Kwajalein Safety Office
LMSC, Inc. -- D. P. Mercado	(408) 742-0759	(408) 730-8229	
LMSC, Inc. -- Jeff Beckmann			(805) 238-7994 ext. 7012

APPENDIX C

DISTRIBUTION LIST

FOR

Ni^{63} EA

DEPARTMENT OF DEFENSE AGENCIES

U.S. Army Strategic Defense Command
ATTN: CSSD-TD
P.O. Box 15280
Arlington, VA 22215-0280

U.S. Army Strategic Defense Command
ATTN: CSSD-RM
P.O. Box 15280
Arlington, VA 22215-0280

U.S. Army Strategic Defense Command
ATTN: CSSD-EA
P.O. Box 15280
Arlington, VA 22215-0280

U.S. Army Strategic Defense Command
ATTN: CSSD-EN
P.O. Box 1500
Huntsville, AL 35807-3801

U.S. Army Strategic Defense Command
ATTN: CSSD-GI
P.O. Box 1500
Huntsville, AL 35807-3801

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Sunnyvale, CA 94088-3504

Teledyne Brown Engineering
ATTN: Military Applications, MS180
300 Sparkman Drive
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FEDERAL, STATE, AND LOCAL GOVERNMENT AGENCIES

U.S. Environmental Protection Agency, Region 9
ATTN: Office of Pacific and Native American Program
1235 Mission Street
San Francisco, CA 94103

Department of State
ATTN: Office of Freely Associated States Affairs (Rm 5317)
22nd & "C" Street NW
Washington, DC 20520

LIBRARIES

Alele Museum/Library
c/o Ministry of the Interior and Outer Island Affairs
Republic of the Marshall Islands
Majuro, Marshall Islands 96960

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Alexandria, VA 22304-6145